Portland Cement Association

Certifying Portland Cement to ANSI/NSF 61 for Use in Drinking Water System Components

by Howard M. Kanare

SP117

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Addendum

Subsequent to the printing of SP117, the NSF developed new data review submission forms. These forms are in the addendum and replace pages 41 through 46 of SP117.

GENERAL INFORMATION
TOXICOLOGY DATA REVIEW SUBMISSION - A - FORM
NSF *International*
STANDARD 14: PIPES AND RELATED PRODUCTS
STANDARD 61: DRINKING WATER SYSTEM COMPONENTS
Section 5: Protective (Barrier) Materials - Portland Cement Only
Section 6: Joining and Sealing Materials
Section 7: Process Media

WHO IS NSF? NSF *International* (NSF) is an independent, not-for-profit organization of scientists, engineers, technicians, educators, and analysts. It is a trusted neutral agency, serving government, industry, and consumers in achieving solutions to problems relating to public health and the environment since 1944. The mission of NSF is to provide clients and the general public with objective, high quality, timely, third-party services at acceptable cost. Services include development of consensus standards, voluntary product testing and certification with policies and practices. All these service's protect the integrity of the registered Mark, education and training, and research and demonstration, all relating to public health and the environmental sciences.

WHAT IS THE DRINKING WATER ADDITIVES PROGRAM? ANSI/NSF Standard 60 (Drinking Water Treatment Chemicals — Health Effects) and ANSI/NSF Standard 61 (Drinking Water System Components — Health Effects) are voluntary consensus standards developed by regulators, industry, product users and specifiers under the guidance of NSF and its consensus standards process. Standard 61 addresses two aspects: (1) Do contaminants leach or migrate from the material into the drinking water; and (2) If so, is the level of migration acceptable from a public health viewpoint? Standard 60 addresses direct treatment chemicals and their contaminants and if the levels of these chemicals are acceptable from a public health viewpoint. NSF's Drinking Water Additives program is a third-party Certification which includes auditing, sampling, testing, toxicology review, and evaluation relating to the potential health effects of drinking water products/materials in accordance with the criteria established in Standards 60/61.

HOW DOES THE PROCESS WORK?

NSF STANDARD 61

The first step towards Certification under NSF Standard 61 (Section 6 & 7) requires the Applicant to complete a Toxicology Data Review Submission Form A (TDRS-A).

After the form is received at NSF, a specialist will identify ingredients in the material which may require additional information. A TDRS-B form may then be prepared for each ingredient and forwarded to the Material Supplier who, in turn, forwards the forms to the appropriate Ingredient Suppliers for completion. Only those ingredients which do not have toxicology information on file require a TDRS-B form. Once all of the TDRS forms have been returned, a Formulation Review is conducted by authorized NSF chemists and toxicologists to determine which analytical tests are necessary to evaluate the Applicant's product. During the selection of the testing protocol for potential contaminants, consideration is given to the degree of toxicological concern as well as the economic and practical limitations of the analytical tests within the constraints of the Standard.

Measured contaminant concentrations are normalized to reflect the levels anticipated "at the tap." Regulated contaminants (those which have a maximum Contaminant Level set by the USEPA) do not require further toxicology evaluation. However, establishing Maximum Allowable Levels for nonregulated contaminants will require additional toxicology review data, either from new toxicology studies initiated at the time of the testing or previously completed and defensible studies. Should additional toxicology data be necessary, NSF toxicologists will work with the Applicant to determine whether or not previous studies or literature sources fulfill the requirements of Standards 61.

CONFIDENTIALITY: Only NSF-authorized personnel shall be allowed to review Form A and B Applicant and Supplier information, which shall be secured according to NSF Confidential Information Security Procedures. Proprietary information will *not* be revealed or provided to Applicants or their Suppliers or third parties *unless* there is prior notarized written approval. However, the sharing of toxicological information between companies is encouraged where such sharing may expedite product certification.

(Over for General Instructions — TDRS Forms A and B) ▶

GENERAL INSTRUCTIONS FOR COMPLETING TDRS FORMS A

Applicants seeking Certification under NSF Standard 61 will have their evaluations expedited if the information in the TDRS-A Form is complete, accurate, and promptly returned. Likewise, the Ingredient Supplier (TDRS-B Form) can expedite the process for the Applicant by promptly returning the forms with complete and accurate information.

SECTION V — HEALTH EFFECTS:

Any toxicology, mutagenicity, teratology, or supporting research reports known to the Applicant or the Suppliers should be identified. Submission of such reports may shorten the overall time needed to complete NSF's toxicology evaluation and may reduce required extraction testing, thereby reducing the amount of the NSF testing and toxicology review fees. Literature references are sufficient when the information is available in scientific journals. Summaries of studies completed within your organization or by contract laboratories should be appended directly to the form. Detailed data may be required at a later date. NSF strongly encourages the Applicant and its Suppliers to collaborate in the review and submission of supporting toxicology data.

Toxicology information from the U.S. Food and Drug Administration (21 CFR), U.S. Environmental Protection Agency (Drinking Water Regulations), World Health Organization, etc. will be used in support of product applications. However, consideration will be given on the basis of regulatory approval (usage, restrictions, current literature, and state of the science). If the supplier asserts that any product, ingredient, impurity, or other chemical introduced into drinking water as a result of product use should be exempt from toxicology review and evaluation, *justification* must be provided. (For example, a detailed justification report would need to be appended where the Applicant or Supplier claims that no residual is found under potable water use conditions, an ingredient is non-migratory, etc.) Reports justifying an exemption must be appended to this Application.

DEFINITIONS — TDRS FORM-A

Applicant: A corporation, company, or individual that manufactures, mines, blends, assembles, packages, repackages, or otherwise produces a direct or indirect additive "product" or material to drinking water for which a Listing is sought.

Material Supplier (Form A): A corporation, company, or individual (possibly the Applicant) which manufactures a material used in the final production of the Applicant's "product".

Ingredient Supplier (Form B): A corporation, company, or individual that provides an ingredient used by the component supplier to produce its material.

Component: A sub-unit or part of the Applicant's "product"; e.g., a valve, a valve stem, a tank liner, a pump, a filter, etc.

Material: A homogeneous and defined formulation of ingredients composing a component in the Applicant's "product"; e.g., PVC in a plastic pipe, a rubber gasket in a valve, activated carbon in a filter, brass in a valve body, etc.

Product: For the purpose of completing the TDRS-A and TDRS-B Form, the subject of the form (i.e., the chemical, material for which the form is requested) will be considered the "product".

Ingredient: As used in Forms A and B, a constituent used in the production of the "product" for which the form has been requested.

Impurity: A chemical or substance present in the "product" which contributes neither to the manufacturing process, nor to the function of the "product".

By-Product: A chemical produced during the manufacturing process which is not part of the original starting materials and which is not the major or intended final "product".

Reactant: A chemical used in the manufacturing process of the Applicant Product, or a substance that enters into, and/or is altered in the course of a chemical reaction.

Direct Additives: Chemicals added to water in the production of drinking water.

Contaminant: Any physical, chemical, biological, or radiological substance or matter present in the product which is not part of the original formulation.

Table 1
CATEGORY AND FUNCTION CODE LIST

(Sections noted below refer to section numbers in NSF Standard 61)

CATEGORY	CODE *(Select One)*
Joining and Sealing Material (Section 6)	JASM
Process Media (Section 7)	PRMD
Plastic Materials	MATL
Generic Ingredients (Standard 14)	GENR
PPI/PVC Range Formula Ingredients (Standard 14)	PPIR
Protective (Barrier) Materials (Section 5) (Portland Cement, Admixtures, Mold/Form Release Agents and Concrete Sealers)	CMNT

FUNCTION	CODE *(Select One)*
Absorption	ADS
Activated Alumina	ACA
Adhesives	ADH
Admixture	ADM
Aeration	AER
Aeration Packing Material	APM
Anthracite	ANT
Brazing/Solders/Fluxes	BSF
Caulks	CAU
Cement	CMT
Cement - Hydraulic	CMH
Cement - Portland	CMP
Chelation	CHL
Chelating Polymers	CHP
Clarifier Media	CLM
Concrete Sealers	CNS
Concrete Admixtures	CON
Concrete Release Agents	CRA
Diatomaceous Earth	DIE
Filtration/Absorption Media	FAM
Filtration Media	FLT
Filter Rock	FTR
Granular Activated Carbon	GAC
Gaskets	GAS
Garnet	GNT
Grouts	GRT
Gravel	GRV
Gasket/Sealing Materials	GSK
Ilmenite	IMN
Ingredient	ING

FUNCTION	CODE *(Select One)*
Ion Exchange Resins	IXR
Joining Materials	JNG
Lubricants	LUB
Material	MTL
O-Rings	ORG
Oxidative Media	OXI
Powdered Activated Carbon	PAC
Patching Materials	PTM
Potable Water Materials	PWM
Sand/Gravel	SGV
Sealants	SLT
Sand	SND
Solvent Cements	SVC
Synthetic Media	SYM
Tread Compounds	TCP
OTHER	OTH

TOXICOLOGY DATA REVIEW SUBMISSION (TDRS)-FORM A
NSF *International* (NSF)
FOR ASSISTANCE: 1-800-252-6010 or 313-769-8010
From 9am to 4pm Eastern Time

NSF USE ONLY
Standard_____
DCC:_____
Company No.:_____
Accepted By:_____
Date of Certification:_____

STANDARD 61: DRINKING WATER SYSTEM COMPONENTS

Section 5: Protective (Barrier) Materials -
(Portland Cement, Admixtures, Mold/Form Release Agents and Concrete Sealers)
Section 6: Joining and Sealing Materials
Section 7: Process Media
Plastic Materials
Generic Ingredients (Standard 14 only)
PPI/PVC Range Formula Ingredients (Standard 14 only)

(CONFIDENTIAL INFORMATION)

I. IDENTIFICATION INFORMATION

Company name _____ Company contact _____

Address _____ Telephone number ( )_____

_____ FAX number ( )_____

_____

_____

IMPORTANT: If the product formulation is identical and the product is manufactured at more than one plant location, add as an attachment to this form a list of plant addresses and a plant contact for each site. If the formulation is different in any way, for multiple plant locations, a form must be completed for each plant.

Plant name _____ Plant contact_____

Address _____ Telephone number ( )_____

_____ FAX number ( )_____

_____

II. PRODUCT INFORMATION

1. Product Name/Trade Designation

_____

Additional Names/Designations for Same Product

_____

_____

_____

2. Indicate category code and function code for product (see Table 1 for codes). If more than one category or function please complete a separate TDRS-A form for each category and/or function.

Category Code_____ Function Code_____

3. For Portland Cements, Admixtures, Joining and Sealing Materials, and Plastic Materials indicate the maximum water temperature to which your product or material can be subjected under normal operating conditions. (Process Media is evaluated at cold only.)

☐ Cold (78°F/23°C) ☐ Domestic hot (140°F/60°C) ☐ Commercial hot (180°F/82°C)

4. For Plastic Materials. indicate end use.

a. ☐ Pipe ☐ Fittings ☐ Other _____

Standard 61, 14 & S4 Applicants Only

5. Indicate size range or surface area-to-volume ratio of product for which Certification is being requested in in^2/gallon or cm^2/liter

_____

Plastic Material Applicants Only

6. Indicate Compounder Classification

a. ☐ Material Supplier ☐ In-Plant Compound (proceed to part b) ☐ Special Compounder

b. If you are an in-plant compounder list formulation source (if transferred)

_____

7. Indicate cell class. type and grade.

Cell Class _____

Type & Grade _____

ASTM Reference _____

Portland Cements and Admixtures Applicants Only

8. Are waste derived fuels and/or raw materials used in the generation of this cement?

Yes ☐ No ☐

9. Are grinding aids or other post kiln processing aids used in the manufacture of the cement?

Yes ☐ No ☐

If yes, identify on page 3 of 6.

10. Is there a specific end use for the cement manufactured here or can it be used for any application?

Tanks/Reservoirs ☐ Pipe/Fittings ☐ Any Application ☐

Cementitious Coatings ☐ Grout/Patching Compound ☐ Other ☐

Water contact surface area to volume ratio? _____ in^2/gallon(liter)

11. List maximum use of admixtures _____.

III. FOI LATION INFORMATION: (All information documented is held in s :onfidence.)

List the formulation and related information as follows:

Chemical Abstract Service Number (CAS No.)	Chemical Name	Trade Name	Supplier(s) (Include Alternate Suppliers) 1 Supplier Per Line	I,R,P*	Composition		TDRS-B Info (NSF Use Only)
					%	Parts by Weight (PHR)	

*Indicate whether an ingredient (I) or Reactant (R) or Processing Aid (P).

PLEASE TYPE AND DO NOT ABBREVIATE

IV. PRODUCTION AND CHEMICAL INFORMATION

1. Is the product _____ mined or _____ manufactured?

   a. If mined, is it purified? YES ___ NO ___
   If YES, how?_____
   Is it ground or mixed to a homogeneous mixture? YES ___ NO ___

   b. If manufactured or synthesized, provide the following:
   Please provide separate attachments as necessary.

   Manufactured:
   1. How is the product manufactured?

   ☐ blended (compounded) ☐ vulcanized
   ☐ extruded ☐ other_____
   ☐ compression/injection molded

   Synthesized:
   1. Recognized name of synthesis:_____
   2. Purification procedure_____
   3. Provide the analytical procedure for the analysis of your product. Provide either a literature reference or a written procedure_____
   4. Molecular weight (molecular weight distribution for polymers)_____
   5. Itemize the reaction products of initiators, stabilizers, and catalysts used in the manufacture or synthesis of your product.

2. Are any recycled or reprocessed materials used in this product? ___ YES ___ NO. If yes, provide a separate attachment describing how impurities and lot-to-lot variations are controlled.

3. How is the product handled/packaged? ☐ Single use (dedicated) system. ☐ Multiple use (non-dedicated) system.

   If multiple products are handled, list other products handled.

   _____ _____
   _____ _____
   _____ _____

4. Itemize below, known or suspected impurities in the finished product including, but not limited to, unreacted starting materials, by-products, low molecular weight polymers, etc. If available, provide literature reference(s) or written procedure(s) for the identification of impurities in your product and starting materials.

Chemical Name	Amount % or ppm	CAS #	Analytical Method

V. MIGRATION/EXTRACTION INFORMATION

1. Have tests been run on your product to determine migration/extraction levels of the MATERIAL, CONTAMINANTS or IMPURITIES from your product into water? ___ YES ___ NO

   If the answer is yes, please append the complete report(s) for every component or impurity studied, including a copy of the analytical method or a literature reference to the method.

VI. HEALTH EFFECTS

Analysis of the Applicant's product will be conducted to identify potential contaminants to the drinking water. Laboratory values of contaminant concentrations will be normalized to "at-the-tap" values. Those contaminants for which the Environmental Protection Agency has not established a Maximum Contaminant Level (MCL) may require additional toxicity testing according to the guidelines of ANSI/NSF Standards 60/61, Appendix A. Information you provide (as attachments to this form) regarding your knowledge of specific toxicology studies will expedite the applicant's Certification and may alleviate the need for additional toxicity testing.

1. Toxicology Studies: As an attachment to this form, please provide a detailed list of all known published and unpublished toxicology studies (acute, subchronic, chronic, mutagenicity, teratogencity, reproductive, carcinogenicity, epidemiology, etc.) relevant to your product, materials, ingredients, and/or impurities. For each reference include:

   a. Name of specific material, ingredient, or impurity addressed by the study.
   b. Type of study (Ames, Sister Chromatid Exchange, etc.).
   c. Complete reference: (author[s], title, source, volume, pages, year).
   d. Summary of study results (include ALL treatment-related effects; provide your opinion, with justification, for any results you feel should be discounted; attach complete reports, if desired).

___ (Check if no knowledge of toxicity data exists within your company related to this Listing application).

2. A toxicology literature search provided by your company may expedite the toxicology review and minimize costs to the applicant for obtaining toxicology data. For each literature search appended to this form, itemize as described below:

Database	_____	_____	_____
File #	_____	_____	_____
Keywords	_____	_____	_____
Date	_____	_____	_____

___ (Check if no literature search has been, or will be, conducted by your company.)

VII. ATTACHMENTS

List attachments to this form _____ No. of Pages _____

_____ _____

_____ _____

_____ _____

_____ _____

VIII. CERTIFICATION STATEMENT:

I hereby certify that the information provided is accurate and complete, and that I, and the Company I represent, know of no reason the product/material described herein should not be used in contact with drinking water.

Signature _____ Date _____

Typed or printed name _____

Position/Title _____

Company _____

Phone (___) _____ FAX (___) _____

IX. DID YOU???

- ❑ Sign the form.
- ❑ List 1 ingredient/supplier per line.
- ❑ List appropriate trade name for each ingredient.

IX. RETURN INSTRUCTIONS:

WHERE TO MAIL? INSERT COMPLETED FORM IN AN ENVELOPE MARKED "CONFIDENTIAL BUSINESS INFORMATION". SEAL IN AN OUTER ENVELOPE, AND RETURN TO:

VIA U.S. MAIL:
Additives Toxicology Group
NSF *International*
P.O. Box 130140
Ann Arbor, MI 48113-0140

VIA COURIER SERVICE:
Additives Toxicology Group
NSF *International*
3475 Plymouth Road
Ann Arbor, MI 48105

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Certifying Portland Cement to ANSI/NSF 61 for Use in Drinking Water System Components

by Howard M. Kanare*

FOREWORD

This document explains the process leading to certification of cement for use in drinking water system components, and is organized as follows:

- **An overview** of the relevant ANSI/NSF 61 standard, activities of the Portland Cement Association Task Group on Drinking Water Issues, and results of laboratory tests is given in the Executive Summary on page 1.
- **Background information** begins on page 1, including the role of cement in drinking water systems, the history and coverage of ANSI/NSF 61, state implementation plans, and explanation of the National Primary Drinking Water Standards. Details of the implementation plans for all 50 states in the U. S. are given in Appendix A and the complete NPDW Standards are shown in Appendix B.
- **Cement industry issues** are discussed beginning on page 3, including details of coverage of cement-based products in Standard 61 and activities and results of the PCA Task Group on Drinking Water Issues.
- **Procedures for testing cement** for certification to Standard 61 can be found beginning on page 4. The addresses and contacts for application to the two ANSI-accredited certifying organizations (NSF International and Underwriters Laboratories) are given on page 5.
- **Published literature** on health issues for cement in drinking water systems is reviewed beginning on page 6. A brief discussion of the differences between results obtained following the two relevant testing protocols in Standard 61 is provided on page 7.
- **A guidance document** for cement companies to follow when preparing applications to NSF International for cement testing is given in Appendix C. Applications and information forms for NSF International and Underwriters Laboratories are in Appendices C and D.
- **Mortar cube fabrication method** developed at CTL to test cements under Standard 61 is shown in Appendix E. Details of test procedures and results leading to the comparison of the two relevant test protocols in Standard 61 are described in Appendix F.
- **A complete copy of ANSI/NSF 61** is attached at the end of this document.

COMMONLY ASKED QUESTIONS ABOUT TESTING AND CERTIFICATION OF CEMENT AND CEMENT-BASED PRODUCTS UNDER ANSI/NSF 61

Q: What is ANSI/NSF 61?

A: A relatively new standard, *ANSI/NSF 61 – Drinking Water System Components-Health Effects*, is being adopted by nearly every state in the U. S. to assure that products such as pipe, coatings, process media, and plumbing fittings are safe for use in public drinking water systems. Cement is used in drinking water system components such as pipe and tanks, and therefore, is subject to testing under Standard 61. A complete copy of Standard 61 is attached at the end of this document.

Q: How do I get cement tested to meet Standard 61?

A: You must apply for certification to one of the two ANSI-accredited certifying organizations, NSF International of Ann Arbor, Michigan, or Underwriters Laboratories of Northbrook, Illinois.

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* Principal Scientist and Group Manager, Chemical Services, Construction Technology Laboratories, Inc., 5420 Old Orchard Road, Skokie, IL 60077. Phone: (708) 965-7500, Fax: (708) 965-6541.

Q: What is the certification process?

A: You first complete an application and information forms and submit them to one of the certifying organizations. They will review your information about your manufacturing process and then arrange for an inspection and audit of your cement plant. (Each cement plant must submit a separate application for certification.) They will obtain samples of cement and make mortar cubes which will be exposed to synthetic drinking water under laboratory conditions. The water will be analyzed for possible contaminants and the results of analyses will be compared to Maximum Acceptable Levels, generally ten percent of the U. S. EPA National Primary Drinking Water Standards. If the cement passes the tests, it will be listed in the certifying organization's listing book of approved products and you will be permitted to mark your product with the certifying organizations registration mark ("NSF" or "UL"). The NSF certification process includes conformity with Standard 61 and with NSF certification policies. Certification is verified annually by unannounced plant visits and follow-up testing.

Q: Is cement certification required for use in drinking water system components?

A: No, unless the cement is made with hazardous waste derived fuels or hazardous waste raw materials. Standard 61 is an "end product" (pipe, tank, etc.) standard; the end product must be tested but *constituents* of end products generally are not tested. However, it is advantageous to cement producers to have cement certified since a certified cement will be "prequalified" for use in mortar and concrete products intended for drinking water systems. Prequalification of cement will speed up certification of concrete products and permit interchange of cements in certified products, such as pipe, without recertification each time a change in cement is made. In addition, certified cements may carry the certifying organization's mark indicating the cement has passed Standard 61.

Q: What about cement made with hazardous wastes?

A: Although not explicitly required in Standard 61, it is NSF and UL policy that cement made with a hazardous waste fuel or a hazardous waste raw material must be tested by itself (in mortar cubes) before testing products made with the cement. Any cement can be tested to the Standard and all cements will be tested to the same acceptance criteria. Prior to the current edition of Standard 61 (which now covers cement certification as a constituent) NSF International had a moratorium on testing cement-based products made with hazardous waste fuels. The requirement for testing cement recognizes the controversy surrounding cements made with hazardous wastes and establishes a "double hurdle" for such products. To date, NSF testing has shown no differences resulting from use of hazardous waste fuels, and their policy might change in the future.

Q: Have any cements been tested?

A: Yes. As part of research projects in the U. S. and Europe, many cements have been tested according to several different test protocols. All of these cements have been shown to be acceptable for use in drinking water systems, including cements made with hazardous wastes.

Q: What about cement products such as concrete pipe and tanks already in use?

A: Local water supply agencies must test drinking water *at the tap* for compliance with the U. S. EPA National Primary Drinking Water Standards. Thus, any contaminants from sources in the drinking water distribution system would be detected and corrected by the local agency. We are not aware of any reports of such problems related to the use of concrete products in drinking water systems.

Q: Why should we certify?

A: Certified cements will be acceptable for use in drinking water system components such as pipe and tanks. While end products such as pipe must be tested, a pipe manufacturer could switch between brands of certified cement without having to retest the pipe itself. Concrete producers will be able to choose from among certified cements which will speed up the approval for concrete projects. At some time in the future, some agencies might begin to require certified cement for use in dams, embankments, and other places in drinking water systems. There is also the intangible benefit of having the certifying organization's mark on your product when sold for general construction purposes, indicating the cement has passed rigorous testing and is safe for use even in drinking water systems.

Q: Must all certified cements be labeled with a registration mark?

A: NSF Product marking requirements are primarily intended to establish product traceability and to distinguish certified and non-certified products in the marketplace. This intent is accomplished through NSF program policies. NSF will grant variances to these policies as long as the product markings are not confusing as to which products are NSF certified. In the event of a variance, a note shall be placed in the listing book that explains how certified and non-certified products will be distinguished in the marketplace.

EXECUTIVE SUMMARY

Portland cement is used to make drinking water system components that transport and store drinking water. ANSI/NSF 61 is a voluntary consensus standard, first published in 1988 and most recently revised in January 1995, that provides means for evaluating products (such as pipe) that are components of drinking water systems by testing for contaminants that might enter into drinking water. The Standard was developed and is maintained by NSF International, a non-profit organization with headquarters in Ann Arbor, Michigan. An annual survey by the Association of State Drinking Water Administrators indicates every state, with the exception of Wyoming, intends to implement ANSI/NSF Standard 61 either through regulations or policy. Therefore, portland cement and cement-based products will be subject to scrutiny under the Standard.

A task group of Portland Cement Association members, staff, and contractors worked to obtain revisions to Standard 61 so that cement could be tested and approved for use in drinking water system components such as mortar-lined steel pipe, dams, aqueducts, and concrete storage tanks. The revisions have been approved and are now part of the Standard. Another result of the task group's work is a document titled, *Guidance Document for Cement Companies Preparing ANSI/NSF 61 Applications for Submission to NSF International* (Appendix C). This document explains how to provide the information requested on NSF International's forms in terms familiar to cement plant staff. A third outcome of the task group's work is that any cement can be tested to the Standard and all cements will be tested to the same acceptance criteria. (Previously, NSF International had a moratorium on testing cement made with hazardous waste fuels.)

PCA-sponsored research at Construction Technology Laboratories compared two different protocols for pipes and barrier materials in Standard 61. For the one cement tested, nearly all analytes (metals, volatile organics, dioxin, radionuclides) were below detection limits in all extraction waters, leaving very few results to look for differences between the test methods. Of the few elements detected, chromium and aluminum appear significantly more soluble in the pH 10 extraction waters than in the pH 5 extraction waters. Dissolution rates appear to be non-linear since normalization of both protocols to 24 hr does not produce the same results. For the cement tested, the barrier material protocol appears to be a more stringent test for radionuclides while the pipe protocol appears to be a more stringent test for aluminum. The overall results are consistent with those published by other organizations: Portland cements tested to date according to protocols in ANSI/NSF 61 are acceptable for use in drinking water system components.

BACKGROUND

Portland Cement in Drinking Water Systems

Portland cement is used to make drinking water system components that transport and store drinking water. High-quality drinking water would not be readily available throughout the U. S. without cement-based products such as dams, soil-cement linings for reservoirs, precast and cast-in-place concrete storage tanks, aqueducts, concrete pipe, mortar-lined ductile iron pipe, and concrete water purification plant treatment tanks.

Until several years ago, no standard specification or test method existed to assess the potential of products to impart contaminants into drinking water systems. That need was met with the creation of a voluntary consensus standard, *ANSI/NSF 61 Drinking Water System Components–Health Effects*, developed to establish minimum requirements for the control of potential adverse human health effects from products which contact drinking water[1]. Another standard, NSF 60, was developed to cover drinking water treatment chemicals.

ANSI/NSF 61 – Drinking Water System Components – Health Effects

ANSI/NSF 61 is a voluntary consensus standard that covers materials or products that come into contact with drinking water. A complete copy of the Standard is attached at the end of this document. Standard 61 provides means for evaluating components of drinking water systems by testing for contaminants that might enter into drinking water. Standard 61 was developed by a consortium comprising NSF International, the American Water Works Association Research Foundation, the Association of State Drinking Water Administrators, the Conference of State Health and Environment Managers, and the American Water Works Association. NSF International was the lead organization in the consortium that developed Standard 61 which was funded in part by the U. S. Environmental Protection Agency to replace the EPA Additives Advisory Program. (NSF International is an independent, not-for-profit organization whose services include development of consensus standards, product testing, and certification, all relating to public health and environmental sciences.) Standard 61 was adopted by the NSF Board of Trustees in 1988 and approved by the American National Standards Institute in 1993.

Two organizations are currently ANSI–accredited to provide product testing services for industry in accordance with Standard 61, NSF International of Ann Arbor,

Michigan and Underwriters Laboratories of Northbrook, Illinois. These certifying organizations do not have a mutual recognition agreement. At present, products tested and listed by NSF are acceptable to UL, but the converse is not true.

Standard 61 was developed to evaluate *end products*. The revisions discussed in this report permit cement to be tested for use as a *constituent* in some end products. NSF International has chosen to include cement under the section that covers barrier materials. Typical products that may be tested to meet Standard 61 include:

- pipes
  - water system transmission pipes
    (including finished products such as mortar-lined pipe, concrete pressure pipe, tanks)
  - residential and commercial pipes
  - tubing, hoses , and fittings
  - tanks
- barrier materials
  - coatings
  - bladders
  - linings ***(including cement)***
- joining and sealing materials
  - fluxes
  - joining materials
  - lubricants
  - gaskets
- process media
  - ion exchange resins
  - filtration media
- mechanical devices
  - chemical feeders
  - disinfection generators
- plumbing products
  - faucets

The certification procedure includes the following steps:

1. Product formulation and component toxicology information are collected and reviewed.
2. The manufacturing facility is inspected and audits of the manufacturing process are performed.
3. Laboratory analyses of the product are conducted.
4. Toxicology reviews of the analytical results are performed. Results are normalized to field conditions and then compared to Maximum Allowable Levels of contaminants, generally ten percent of the EPA National Primary Drinking Water Standards.
5. Recommendations regarding product certification are made.
6. The product is listed in the certifying organization's directory and the manufacturer may place the certifying organization's mark on the product.

ASDWA Survey

Standard 61 is gaining importance. In November 1992, the Association of State Drinking Water Administrators issued results of a survey[2] of all 50 states in the U.S. on adoption of ANSI/NSF Standards 60 and 61. This survey was updated in November 1993 and in January 1995. The latest version (Appendix A) includes a table indicating the status of individual state policies, including citations and effective dates of state regulations. The report indicates, **"Every state, with the exception of Wyoming, intends to implement ANSI/NSF Standards 60 and 61 in some way."**

As of the latest survey date, 27 states have adopted legislation or regulations requiring compliance with the Standards. Twelve other states accept Standard 61 as policy. Thirty-four states require an ANSI-accredited certifier and four more plan to do so. Other states might rely on the manufacturer's certification or require an ANSI-accredited certifier at a later date.

National Primary Drinking Water Regulations

The National Primary Drinking Water Regulations are found in the Code of Federal Regulations at 40 CFR Parts 141, 142, and 143. The regulations specify Maximum Contaminant Levels defined as "Maximum permissible level of a contaminant in water which is delivered to any user of a public water system." Also listed for some contaminants is a Maximum Contaminant Level Goal (MCLG) defined as "A non-enforceable concentration of a drinking water contaminant that is protective of adverse human health effects and allows an adequate margin of safety." Forty-five contaminants have MCLGs set at zero.

An EPA publication, *Drinking Water Regulations and Health Advisories*, (EPA 822-R-94-001, May 1994) contains the latest revisions of contaminant level standards. A copy of this publication is attached as Appendix B. The latest revision of the publication and some help with interpretation of the regulations can be obtained by calling

Safe Drinking Water Hotline
1–800–426–4791
Monday – Friday 8:30 am – 5 pm EST

Regulations concerning drinking water followed the Safe Drinking Water Act (40 FR 34324) in 1975. A number of changes have been made to the regulations since then. The most recent proposed rule for National Pri-

mary Drinking Water Standards was published in the Federal Register in July 1990 (55 FR 30370) and the final rule was published in January 1991 (56 FR 3526). In July 1991, provisions were published for monitoring eight volatile organic compounds along with MCLGs for several pesticides and barium (56 FR 30266). The most recent proposed rule for radionuclide MCLGs and regulations was published in July 1991 (56 FR 33050) which is expected to be final in April 1995. Revisions to the Primary Drinking Water Standards have increased the number of regulated contaminants from 26 organic compounds to over 70, from 6 inorganic contaminants to 23, and from no radionuclides to 6 species. (The first regulations were interim primary regulations promulgated in December 1975 which governed microbiological, chemical, and physical contaminants, not radionuclides.) Considering the many MCLGs set at zero and the increasing ability of analytical techniques to measure low concentrations, it is likely in coming decades that MCLs will be lowered and additional contaminants will be regulated.

CEMENT INDUSTRY ISSUES

Cement Products Covered in Standard 61

Products of the cement and concrete industry are covered by ANSI/NSF 61 in several ways. This subject is confusing because various materials fall under different portions of Standard 61:

Finished pipe products such as concrete pressure pipe or mortar-lined steel pipe are covered in ANSI/NSF 61 Section 4 "Pipes and Related Products." These products must be tested according to the protocol for Pipes and Related Products in ANSI/NSF 61 Appendix B Section 3. (The numbered sections in the body of Standard 61 do not match the numbered sections in Appendix B.) Pipe manufacturers must submit finished pipe specimens for testing. Cement used in pipe manufacture need not be tested separately unless it is manufactured using hazardous wastes *(See below)*.

Portland cement is covered in ANSI/NSF 61 Section 5 "Barrier Materials." Cement testing follows the protocol for Barrier Materials in ANSI/NSF 61 Appendix B Section 4. Mortar cube specimens are extracted in synthetic drinking water under precisely specified conditions of time, temperature, and volume. The certifying organization uses the results of extraction water analyses to calculate the smallest diameter pipe in which the cement could be used so that leachable contaminants will not exceed the Maximum Allowable Levels defined in Standard 61. However, a manufacturer can request actual pipe tests for certification of smaller diameter end product pipe made with that cement. (Larger pipes carry larger volumes of water; when cube test results are normalized, larger pipes have lower contaminant concentrations.)

The water conditioning and extraction procedure for barrier materials is more vigorous than for finished pipe products. If a manufacturer requests cement be tested to the pipe protocol, NSF can do so by issuing an internal *waiver* and then listing the cement with a note. Issuance of such a waiver anticipates that a specific change in Standard 61 will be proposed.

A cement manufacturer *may* choose to have its cement tested so the cement will be qualified for use in concrete or mortar drinking water products. However, cement manufactured using hazardous waste *must* be tested before NSF International or Underwriters Laboratories will test a product made with that cement.

Concrete for cast-in-place or precast structures, such as elements for water storage or treatment tanks, can be tested to meet the requirements of Standard 61. However, NSF International and Underwriters Laboratories have indicated their willingness to expedite the usually lengthy process of certification by allowing some constituents to be pre-qualified. If the cement and admixtures to be used on a particular job are qualified, then concrete specimens made with jobsite aggregates must be tested only for extractable metals and radionuclides. This procedure should be especially useful to concrete producers bidding jobs with short lead times that require certification of concrete mixes.

Admixtures and **mold/form release agents** are covered in Standard 61 Appendix B Section 4.2.3.

Activities of PCA Task Group on Drinking Water Issues

The Portland Cement Association was contacted by several cement companies beginning in 1990 with questions about the applicability of ANSI/NSF 61 to cements. Pipe producers who were attempting to get their products certified under Standard 61 were asking cement companies to provide information for the various NSF International forms.

In 1991, to respond to cement and concrete producers, NSF International staff agreed to look into the possibility of adding sections to Standard 61 to permit testing cement for use as a constituent in products. The idea was to allow cement producers to have cement tested and qualified for use in drinking water system components. A cement certified to ANSI/NSF 61 could then be used in concrete or mortar products by a cement company customer without the customer having to retest its cement-containing products when changing cement

sources. An intangible benefit would be that cement sold for general construction purposes could carry the UL or NSF label indicating that the cement meets the rigorous health criteria in Standard 61. For cast-in-place products such as concrete tanks, use of a certified cement would facilitate certification of the proposed concrete mix.

A Task Group comprising PCA staff and PCA member company representatives met with NSF International staff on numerous occasions beginning in 1991 and developed an addition to Standard 61 for testing cement in mortar cubes. The original intent of the Task Group was to develop a stand-alone section in Standard 61 for testing cement. However, NSF International staff indicated that cement is a component of concrete pipe or mortar linings for steel pipe and functions as a barrier material; therefore, their view was that cement testing must be in accordance with the barrier materials portion of the Standard. The draft method was revised for incorporation in the appropriate sections of Standard 61, was approved by all levels of the NSF International review process and is now part of the Standard. Because the revised version of NSF 61 has been accepted by ANSI, the testing of cement is now part of an American National Standard.

The Task Group discussed with NSF International staff the cement and concrete industry's needs so that companies applying for certification would understand the provisions and processes required by Standard 61. One result of these discussions is a document titled, *Guidance Document for Cement Companies Preparing ANSI/NSF 61 Applications for Submission to NSF International* (Appendix C). This document explains how to provide the information requested on NSF International's forms in terms familiar to cement plant staff. This document also should be useful for completing UL's forms (Appendix D) which request similar information. PCA staff also provided educational materials and information about the cement manufacturing process to the certifying organizations so that reviewing toxicologists can deal knowledgeably with cement company applications for certification.

Testing Cements to ANSI/NSF 61

The process for evaluating and testing cement to Standard 61 is as follows. First, based on a review of materials used to manufacture a cement or cement-based product, toxicologists will recommend analyses for specific potential contaminants. Since cement is made with materials that are primarily inorganic and geological in origin (for example, limestone, fly ash, waste sand, mill scale), toxicologists will require testing for twelve regulated trace metal elements (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium) and radionuclides. Organic compounds such as grinding aids or dust suppressants used in cement manufacture might require some organic analyses. If waste fuels are burned, further organic analyses for dioxins and other compounds might be required. Each cement is reviewed individually; discernment of possible contaminants is based on the particular materials and fuels used in the specific cement manufacturing process.

The certifying organization, or its designee, will obtain samples of cement at the cement plant. Cement samples will be collected in specially cleaned containers in a manner to preclude trace contamination. The samples will be sealed and shipped to a laboratory that will fabricate mortar cubes according to the procedures in Standard 61 if the fabrication procedures cannot be performed at the cement plant. These procedures are similar to ASTM C 109, *Standard Test Method for Compressive Strength of Hydraulic Cement Mortars* except that precautions are taken to avoid contact with contaminants: mortars are handled with non-contaminating tools and placed into polypropylene molds, then moist-cured 28 days in special apparatus to avoid curing-water leaching of constituents. The cured cubes are air-dried for a week, then conditioned and extracted. Protocols for time, temperature, conditioning, exposure, and composition of extraction waters are specified in Standard 61. A detailed procedure for cube fabrication, moist-curing, and air-drying developed at CTL is attached as Appendix E.

The extraction waters are analyzed for contaminants selected by the toxicologists as described above. Contaminant concentrations are divided by three to account for the 72-hr laboratory extraction period versus the 24-hr human exposure basis for the EPA MCLs. Concentrations of contaminants are further normalized to account for the difference between the ratio of the specimen surface area to extraction water volume in the laboratory versus the product in the field:

$$NF = N1 \times N2$$

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F\,(static)}}$$

$$N2 = \frac{V_{F\,(static)}}{V_{F\,(flow)}}$$

where

NF = normalization factor

SA_F = surface area exposed in the field (e.g.- inner surface area of pipe)

SA_L = surface area exposed in laboratory (e.g.- mortar cube surface area)

V_L = volume of extraction water used in laboratory

$V_{F\,(static)}$ = volume of water the product is exposed to in the field for the static condition

$V_{F(flow)}$ = volume of water the product to in the field under flow conditions during a period of time equivalent to the laboratory test

For pipes with inner diameters greater than 100 mm (4 inches), N2 = 1.

Resultant concentrations are not normalized for the difference in cement factor between mortar cubes and concrete because contaminant concentration in the product might not relate linearly to contaminant concentration in the extraction water under the specified test conditions.

The normalized results are then compared to Maximum Allowable Levels of contaminants defined in ANSI/NSF 61 Section 3. MALs of contaminants in the extraction waters, after normalization, are ten percent of the EPA Primary Drinking Water Standard MCLs. (The ten percent criterion is based on the assumption that any one contaminant might come from more than one system component.) For example, the EPA MCL for chromium is 0.1 mg/L (100 ppb); the maximum allowable level in extraction water, after normalization, is 0.01 mg/L (10 ppb). Concentrations greater than the MAL may be justifiable. For example, a mortar cube extraction water containing 8-10 pCi/L normalized gross beta particle activity exceeds ten percent of the EPA MCL for beta particle emissions (5 pCi/L); such emissions are commonly due to naturally-occurring ^{40}K. Because U. S. adults ingest 2,300 pCi ^{40}K per day, mostly from foodstuffs[3], the amount coming from drinking water is negligible by comparison. NSF International toxicologists use this reasoning to calculate an acceptable MAL for such a contaminant.

For contaminants not regulated in the National Drinking Water Standards, if the contaminant is likely to enter into a drinking water system from only one component, the reviewing toxicologists could raise the MAL to more than one-tenth of the health-based risk.

Applications for ANSI/NSF 61 Certification

A manufacturer that seeks certification can contact an ANSI-accredited certifying organization. Two organizations currently (June 1995) are ANSI-accredited to perform testing to Standard 61:

NSF International
3475 Plymouth Rd
PO Box 130140
Ann Arbor MI 48113-0140
Phone: 313-769-8010
Fax: 313-769-0109
Contact: Mr. Stan Hazan

Underwriters Laboratories Inc.
Engineering Services, 416C
333 Pfingsten Rd.
Northbrook IL 60062
Phone: 708-272-8800
Fax: 708-559-1227
Contact: Mr. Humphrey Sit, ext. 42302

Relationship of Standard 61 Limits to RCRA and BIF Limits

Drinking water MCLs are extremely low compared to levels the cement industry has been concerned with due to other regulations. The Resource Conservation and Recovery Act of 1976, RCRA, and associated laws, empowered the Environmental Protection Agency to develop criteria for evaluating hazardous wastes. Materials can be classified as hazardous wastes either through listing of specific substances, or by one of four characteristics: corrosivity, ignitability, reactivity, or toxicity. Toxicity characteristics are evaluated by subjecting a material to the toxicity characteristic leaching procedure (TCLP, Method 1311) and then analyzing the leachate for concentrations of organic and inorganic contaminants.

In February 1991, EPA issued a final rule for burning hazardous wastes in boilers and industrial furnaces, commonly called the BIF regulations (56 FR 7134). This rule affected cement companies burning hazardous wastes. Part of the rule required analysis of TCLP extracts of cement kiln dust to demonstrate that organic and inorganic toxic constituents reasonably attributable to the hazardous waste are not present at significantly higher concentrations compared to non-waste-derived CKD. The following table compares RCRA toxicity characteristic limits (in the acetic acid TCLP leachate) for twelve inorganic pollutants regulated under BIF to drinking water maximum allowable levels (ten percent of the Drinking Water Standard MCLs):

Element	RCRA BIF Limit, mg/L	ANSI/NSF 61 MAL, mg/L
antimony	1	0.0006
arsenic	5	0.005
barium	100	0.2
beryllium	0.007	0.0004
cadmium	1	0.0005
chromium	5	0.01
lead	5	0.0015
mercury	0.2	0.0002
nickel	70	0.01
selenium	1	0.005
silver	5	[none]
thallium	7	0.0002

To determine if concentrations in drinking water extracts are in compliance with the MALs, a testing laboratory must achieve detection limits roughly one-half the MAL. (Normalization of results for large diameter pipe or tanks permits higher detection limits.) These levels are thousands of times lower than typical environmental laboratory analyses. For some elements, these requirements are stretching the state of the art for commercially available analytical instruments. Laboratories performing tests for compliance with ANSI/NSF 61 must take special precautions to minimize contamination, reduce backgrounds, and achieve the required detection limits.

RESULTS OF PUBLISHED STUDIES

There exists a large body of literature on the leaching of hazardous wastes solidified or stabilized with cement. However, only a few studies have been published concerning the leaching of contaminants from ordinary mortar or concrete drinking water system components into drinking water systems. This section reviews that literature.

Colucci et al[4] analyzed extracts from two sets of mortar cubes, one made with cement produced using waste-derived fuel, and one made without WDF. Cubes were cured in molds 24 hr then air-dried 14 days. Following washing and simulated disinfection, cubes were conditioned following ANSI/NSF 61 Appendix B Section 3.2 (pipe protocol) for 14 days at 23°C with at least 10 changes of water at not less than 24 hr intervals. Samples were extracted following ANSI/NSF 61 Appendix B Section 4.5 (barrier materials protocol) by exposing to pH 5 and pH 10 water for two 24-hr periods, discarding the water, then soaking 72 hr at 23°C and collecting the water for tests. Thus, the cubes were conditioned by at least 12 changes of water for 24 hr each, before exposure for the tests. Results normalized for 60 cm (2 ft) diameter pipe and for 24 hr exposure indicated contaminants well below the MALs. Antimony, cadmium, and chromium in the pH 5 extracts, and nickel and chromium in the pH 10 extracts, ranged from one-tenth to less than one-hundredth of the MALs. Arsenic, barium, beryllium, lead, mercury, selenium, silver, and thallium were not detected in any of the extracts, therefore putting upper limits on their concentrations that are several orders of magnitude below the MALs. Analysis for radionuclides indicated measurable gross beta activity which was determined to be caused by naturally-occurring ^{40}K. The normalized beta activity was less than the MAL.

Germaneau et al[5] tested 4 x 4 x 16 cm mortar bars made from nine commercial cements (including ordinary portland and blended cements) cured in molds one day and air-dried at least one month at 20°C/50% relative humidity. The bars were immersed in Evian™ drinking water at a surface-area-to-volume ratio equivalent to a 10 cm diameter pipe. Extraction waters were changed every 24 hr over five days, with water samples collected at each step. Ten trace metal analytes were determined in the leachates, all of which were below the then current US, European, or French specifications after the fourth step of leaching. All the ordinary portland cements displayed metal concentrations significantly lower than the specification limits which decreased sharply with repeated immersions. The slag cements did not release more heavy ions, even though their metal contents were initially higher. The pH decreased to acceptable levels only after the first three immersion steps. The authors concluded that conditioning with several changes of water prior to exposure for testing is justified.

Kanare and West[6] studied leaching of 3 x 6 in concrete cylinders using four cements and two aggregates (eight different concrete batches), generally following ANSI/NSF 61 protocol for pipe: 14 days conditioning at 23°C with at least twelve changes of water at not less than 24 hr intervals, followed by extraction for 16 hr at 23°C in pH 8 water. Surface-area-to-volume ratio was equivalent to a 91 cm (3 ft) diameter pipe. Extracts were analyzed for eight trace metal elements and for fluoride and nitrate. Values for arsenic, cadmium, selenium, and silver were all below detection limits. Barium, chromium, fluoride, and nitrate were detected at less than one-tenth of the U. S. Primary Drinking Water Standards. Lead and mercury detected in a control sample indicated contamination which was traced to one of the extraction vessels. This work illustrated the absolute necessity for a precise laboratory protocol for testing at these low detection levels.

Baur and Eisenbart[7] performed tests on water stored from 17 to 126 days in five reservoirs. Variables included type of water, wall surface, methods of water treatment, and methods of reservoir cleaning. Storage of five to seven days in reservoirs with cement-based linings did not affect water quality. Chlorinated rubber coatings and chemical cleaners stimulated bacterial growth. Two other studies examined organic pollutants from coatings applied to cement-based linings. Vinyltoluene used to coat asbestos-cement pipes in New England[8] leached tetrachloroethylene in concentrations of a few µg/L to several mg/L in dead ends of the system. Flushing was the most feasible means for decreasing the organic concentrations in the water. Organic solvents from painting a concrete drinking water reservoir with chlorinated rubber coatings[9] were found four months after application at levels exceeding the permissible 10 µg/L. The solvents corresponded to those found in the paint. It

should be noted that barrier materials such as organic coatings for tanks and pipe are tested by the same methods used for cement under Standard 61.

Kajikawa et al[10] detected alkalies, Zn, Fe, Cd, and Pb in water eluates of water pipes made of cement *[sic]* galvanized steel, and PVC. The effect of water quality was studied by comparing the qualities of raw and drinking waters.

Rosich et al[11] performed laboratory studies of leaching of asbestos-cement pipe for water supply in Perth, Australia, finding increases in pH, Ca, alkalinity, and Langelier index after three days water contact with the pipes, with higher values after four weeks contact. Buffering the water with 1.5 mM $NaHCO_3$ did not significantly affect the final values.

Maier[12] found that newly installed mortar lined pipes decreased *[sic]* the pH of the water due to $Ca(OH)_2$ dissolved from the cement. Changes in water composition were affected by length of storage, type of mortar surface, water temperature, volume, and cement type.

In an interesting use of a cement-based product[13], 2000 L "cement jars" have been used since the early 1980's in rural northeastern Thailand to store rainwater for drinking. Villagers are reportedly drinking better quality water for longer periods than before.

DIFFERENCES BETWEEN RESULTS OF ANSI/NSF 61 TEST PROTOCOLS

A test program was conducted by Construction Technology Laboratories under contract with the Portland Cement Association to determine whether mortar cubes subjected to the two drinking water extraction procedures in ANSI/NSF 61 Appendix B produce similar or significantly different results. Details of the methods and results are included in Appendix F. The differences between the two protocols are shown in the following table:

Results indicated nearly all analytes (metals, volatile organics, dioxin, radionuclides) were below detection limits in all extraction waters, leaving few results to study for differences between the test methods. Of the few elements detected, chromium and aluminum appear significantly more soluble in the initial pH 10 extraction waters than in the initial pH 5 extraction waters. Dissolution rates appear to be non-linear since normalization of both protocols to 24 hr does not produce the same results. For example:

	Set A – Pipe Protocol normalized to 24 hr, 6-in pipe		**Set B – Barrier Material Protocol normalized to 24 hr, 6-in pipe**	
	pH 5	**pH 10**	**pH 5**	**pH 10**
Aluminum, mg/L	0.032	0.34	0.019	0.15
Gross beta, pCi/L	5.6	6.1	9.9	8.5

For the cement tested, the barrier material protocol appears to be a more stringent test for radionuclides while the pipe protocol appears to be a more stringent test for aluminum. This is a tentative conclusion based on very few results from only one cement. However, the overall results are consistent with those reported by other organizations: Portland cements tested to date according to protocols in ANSI/NSF 61 are acceptable for use in drinking water system components.

ACKNOWLEDGMENTS

The research reported in this paper (PCA R&D Serial No. 2041) was conducted at Construction Technology Laboratories, Inc. with the sponsorship of the Portland Ce-

Method	Conditioning	Extraction	Results
Pipes and Related Products ANSI/NSF 61 Appendix B Section 3	50 mg/L chlorine disinfection soak 24 hr, then condition 14 days, 23°C, pH 8	16 hr, 30°C initial pH 5 or 10 for metals, pH 8 for organics	normalized for surface area-to-volume ratios
Barrier Materials ANSI/NSF 61 Appendix B Section 4	200 mg/L chlorine disinfection spray then condition 2 days, 23°C pH 5 or 10	72 hr, 23°C initial pH 5 or 10 for metals, pH 8 for organics	normalized to 24 hr and then for surface area-to-volume ratios

ment Association (PCA Project Index No. 91-06). The contents of this paper reflect the views of the author, who is responsible for the facts and accuracy of the data presented. The contents do not necessarily reflect the views of the Portland Cement Association.

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APPENDIX A – ASDWA SURVEY

ASDWA SURVEY ON STATE ADOPTION OF ANSI/NSF STANDARDS 60/61

THIRD EDITION

FINAL REPORT

Prepared by:

Association of State Drinking Water Administrators
1120 Connecticut Avenue, NW, Suite 1060
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January, 1995

Executive Summary

Attached is a chart summarizing state responses from the ASDWA Survey on State Adoption of ANSI/NSF Standards 60 and 61. The survey was conducted via telephone and member mailing during the last two weeks of December, 1994. All 50 states were contacted and responses obtained from all but three states (Maine, Wyoming, and Hawaii).

Of the 47 responding states, 27 now have legislation or regulations in place requiring compliance with the standards, an increase of two states over the 1993 report. Additionally, twelve states accept ANSI/NSF Standards 60 and 61 as part of their policy and five expect to have regulations in place by the end of 1995. With regard to ANSI-accredited certifiers, a total of 34 states now require such accreditation and four more indicate that ANSI certification is planned.

As reported last year, many of the states have enacted legislation, promulgated regulations, or adopted a policy to implement both standards but are still facing difficulty with implementation because of insufficient numbers of products within a category or categories for which no products are currently approved. As in 1993, the survey found this concern to be particularly strong with regard to ANSI/NSF Standard 61.

There are a number of points that should be kept in mind when interpreting the chart:

1) Every state, with the exception of Wyoming, intends to implement ANSI/NSF Standards 60 and 61 in some way.

2) To varying degrees, each state that intends to implement the standards has adopted or plans to adopt legislation, regulations, or policies that accomplish this goal. Identifying each state's degree of implementation, however, requires that columns in the chart be interpreted in combination. The following guidelines should enable you to properly interpret the results:

   a) States with regulations in place. These states responded "Yes" to the question on whether they have adopted legislation or regulations. In addition, they supplied answers to questions about state citations and the date the standards were put in place and when they become effective. Examples: Arizona, Georgia.

   b) States with plans to adopt regulations. These states responded "Yes" to the question on whether they intend to adopt the standard, "No" to whether they have adopted legislation or regulations, and they indicated an expected date for when they believe the regulation will be adopted or become effective.
   Examples: Louisiana, Nebraska.

States that expect to require ANSI-accredited certifiers are indicated by the word "Planned" in the column on ANSI-accredited certifiers.
Examples: New Jersey, South Dakota.

If this column is blank, the state is uncertain whether such a requirement will be adopted.

c) States that intend to adopt the standards, but have no specific plans for when they will adopt legislation, regulations, or policy. These states responded "Yes" to the question on whether they intend to adopt the standard, "No" to whether they have adopted legislation or regulations, and they do not have an expected date for when they believe the regulation will be adopted or become effective.
Example: Connecticut.

d) States that do not intend to adopt the standards. These states responded "No" to the question on whether they intend to adopt the standards.
Example: Wyoming (does not have primacy and will not be adopting the standards).

e) States with policies in place. These states are indicated by the word "Policy" in the column on whether states have adopted legislation or regulations.
Examples: Iowa, Nevada.

States that have policies requiring an ANSI-accredited certifier are indicated by "Yes (policy)" in the column on ANSI-accredited certifiers.
Examples: Colorado, Kansas.

3) Only Washington state indicated that they require additional evaluation of additives beyond Standards 60 and 61.

Responses to ASDWA Survey on State Adoption of ANSI/NSF Standards 60 and 61
(Survey Conducted December, 1994)

***States with program updates/revisions since 1993 survey. Changes shown in bold italics.**

State	Intend to Use Standard		Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Date Regulation Put In Place		Effective Date of Regulations		Additional Evaluation Required
	Standard 60	Standard 61				Standard 60	Standard 61	Standard 60	Standard 61	
Alabama	Yes	Yes	Yes	§335-7-6.10 §335-7-5.18	No	November 9, 1992	November 9, 1992	November 9, 1992	November 9, 1992	No
Alaska*	Yes	Yes	***Yes***	***18AAC 80.340***	No	***June 14, 1991***	***June 14, 1991***	***June 14, 1991***	***June 14, 1991***	No
Arizona	Yes	Yes	Yes	AAC R18-4-215	Yes	August 6, 1991	August 6, 1991	January 1, 1993	January 1, 1993	No
Arkansas	Yes	Yes	Yes	PWS Reg. §VII.F	Yes (policy)	January 31, 1991	Janaury 31, 1991			No
California*	Yes	Yes	Yes	CCR §§64700-64710	Yes	May, 1993	***December 31, 1995***	January 1, 1994	***1996 (anticipated for coatings, pipes and process media)***	No
Colorado	Yes	Yes	Policy		Yes (policy)					No
Connecticut	Yes	Yes	No		No					No
Delaware*	Yes	Yes	Policy		No[1]	***1978***	***1978***			No
Florida	Yes	Yes	Yes	FAC 17-555(3)	Yes	July 27, 1992	July 27, 1992	January 1, 1993 January 1, 1994[2]	January 1, 1993 January 1, 1994	No
Georgia	Yes	Yes	Yes	OCGA 391-3-5	Yes	July, 1992	July, 1992	July, 1992	July, 1992	No
Hawaii	Yes	Yes	Policy		No					No
Idaho	Yes	Yes	Yes	16.01.08.552.02 16.01.08.550.02	Yes (policy)	October 1, 1993	October 1, 1993	October 1, 1993	October 1, 1993	No
Illinois*	Yes	Yes	***No***[3]		Planned					No

[1] Uses NSF list or equivalent as a guide but does not require for compounds not listed under either standard.

[2] For both standards, 1993 is for coatings and chemicals. 1994 is for components.

[3] Revising technical policy statements. Draft anticipated by July, 1995.

State	Intend to Use Standard		Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Date Regulation Put In Place		Effective Date of Regulations		Additional Evaluation Required
	Standard 60	Standard 61				Standard 60	Standard 61	Standard 60	Standard 61	
New Jersey*	Yes	Yes	No		Planned			*December, 1995 (expected)*	*December, 1995 (expected)*	No
New Mexico	Yes	Yes	Yes	WSR §208(k)	Yes	March, 1992	March, 1992	July, 1992	July, 1992	No
New York*	Yes	Yes	Policy		Yes (policy)	*April, 1993*	*April, 1993*	*July, 1993*	*July, 1993*	No
North Carolina*	Yes	Yes	*Yes*	15A NCAC 18c §.1537	*Yes*			*July 1, 1994*	*July 1, 1994*	No
North Dakota*	Yes	Yes	*Yes*[8]	*NDAC 33-17*	*Yes*	*August 1, 1994*	*August 1, 1994*	*August 1, 1994*	*August 1, 1994*	No
Ohio	Yes	Yes	Yes	OAC 3745-83-03	Yes	September 13, 1993	September 13, 1993	September 13, 1994	September 13, 1994	No
Oklahoma	Yes	Yes	Yes/No[9]		Yes (policy)					
Oregon	Yes	Yes	Yes	333-61-087 (05) & (06)	Yes	November 13, 1989	November 13, 1989	November 13, 1989	November 13, 1989	No
Pennsylvania	Yes	Yes	Yes	25 PAC Ch.109.606	No[10]	May 16, 1992	May 16, 1992	May 17, 1993	May 17, 1993	No
Rhode Island	Yes	Yes	Yes	DWQ 4613 §4.1A	Yes	January, 1993	January, 1993	January, 1993	January, 1993	No
South Carolina*	Yes	Yes	*Proposed*		Planned			*July, 1995 (expected)*	*July, 1995 (expected)*	
South Dakota*	Yes	Yes	No		Planned	*1996* (expected)	*1996* (expected)			No
Tennessee	Yes	Yes	Yes	1200-5-1-.17(34)	Yes	February, 1994	February, 1994	January, 1995	January, 1995	No
Texas	Yes	Yes	Yes	TAC 290.42(i)	Yes	September 9, 1992	September 9, 1992	January 1, 1993	January 1, 1993	No
Utah*	Yes	Yes	Yes	*UACR*309-108, 111, 112	Yes	July, 1989	July, 1989	July, 1989	July, 1989	No

[8] No active enforcement before October, 1995.

[9] Regulation is in place but OK is operating under an "exception policy" due to NSF standards delay.

[10] Requires 3rd party certification.

State	Intend to Use Standard		Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Date Regulation Put In Place		Effective Date of Regulations		Additional Evaluation Required
	Standard 60	Standard 61				Standard 60	Standard 61	Standard 60	Standard 61	
Indiana*	Yes	Yes	*Proposed*[4]							
Iowa	Yes	Yes	Policy							No
Kansas	Yes	Yes	Policy		Yes (policy)					No
Kentucky*	Yes	Yes	*Policy*		*Yes*					No
Louisiana*	Yes	Yes	No		No	*December 31, 1995* (expected)	*December 31, 1995* (expected)	*January 1, 1996* (expected)	*January 1, 1996* (expected)	No
Maine	Yes[5]	Yes			No					No
Maryland	Yes	Yes	Yes	COMAR 26.04.01.33	Yes[6]	December, 1992	December, 1992	December, 1992	December, 1992	No
Massachusetts	Yes	Yes	Yes	310 CMR 22.04(6)	Yes	November, 1992	November, 1992	November, 1992	November, 1992	No
Michigan	Yes	Yes	Yes	MI SDWA 165-1993	Yes			September 16, 1993	September 16, 1993	No
Minnesota*	Yes	Yes	Policy		Yes (policy)	*January, 1992*	*January, 1993*			No
Mississippi*	Yes	Yes	Policy		Yes (policy)	*January, 1992*	*January, 1993*			No
Missouri	Yes	Yes	Yes	10 CSR 60	Yes			April, 1992	April, 1992	No
Montana	Yes	Yes	Yes	ARM 16.20:401	Yes	September, 1992	September, 1992	September, 1992	September, 1992	No
Nebraska*	Yes	Yes	No		Planned	*1995* (expected)	*1995* (expected)			No
Nevada	Yes	Yes	Policy		Yes[7]					No
New Hampshire*	Yes	Yes	Yes	ENV Ws 305	Yes	July, *1990*	July, 1992	*January, 1991*	July, *1993*	No

[4]No formal decision made to date on proposed implementation dates.

[5]Use based on NSF approval and listing of a reasonable number of products.

[6]Also accepts third party certification.

[7]Only for NSF listed items.

State	Intend to Use Standard		Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Date Regulation Put In Place		Effective Date of Regulations		Additional Evaluation Required
	Standard 60	Standard 61				Standard 60	Standard 61	Standard 60	Standard 61	
New Jersey*	Yes	Yes	No		Planned			*December, 1995 (expected)*	*December, 1995 (expected)*	No
New Mexico	Yes	Yes	Yes	WSR §208(k)	Yes	March, 1992	March, 1992	July, 1992	July, 1992	No
New York*	Yes	Yes	Policy		Yes (policy)	*April, 1993*	*April, 1993*	*July, 1993*	*July, 1993*	No
North Carolina*	Yes	Yes	*Yes*	15A NCAC 18c §.1537	*Yes*			*July 1, 1994*	*July 1, 1994*	No
North Dakota*	Yes	Yes	*Yes*[8]	*NDAC 33-17*	*Yes*	*August 1, 1994*	*August 1, 1994*	*August 1, 1994*	*August 1, 1994*	No
Ohio	Yes	Yes	Yes	OAC 3745-83-03	Yes	September 13, 1993	September 13, 1993	September 13, 1994	September 13, 1994	No
Oklahoma	Yes	Yes	Yes/No[9]		Yes (policy)					
Oregon	Yes	Yes	Yes	333-61-087 (05) & (06)	Yes	November 13, 1989	November 13, 1989	November 13, 1989	November 13, 1989	No
Pennsylvania	Yes	Yes	Yes	25 PAC Ch.109.606	No[10]	May 16, 1992	May 16, 1992	May 17, 1993	May 17, 1993	No
Rhode Island	Yes	Yes	Yes	DWQ 4613 §4.1A	Yes	January, 1993	January, 1993	January, 1993	January, 1993	No
South Carolina*	Yes	Yes	*Proposed*		Planned			*July, 1995 (expected)*	*July, 1995 (expected)*	
South Dakota*	Yes	Yes	No		Planned	*1996* (expected)	*1996* (expected)			No
Tennessee	Yes	Yes	Yes	1200-5-1-.17(34)	Yes	February, 1994	February, 1994	January, 1995	January, 1995	No
Texas	Yes	Yes	Yes	TAC 290.42(i)	Yes	September 9, 1992	September 9, 1992	January 1, 1993	January 1, 1993	No
Utah*	Yes	Yes	Yes	*UAC*R309-108, 111, 112	Yes	July, 1989	July, 1989	July, 1989	July, 1989	No

[8]No active enforcement before October, 1995.

[9]Regulation is in place but OK is operating under an "exception policy" due to NSF standards delay.

[10]Requires 3rd party certification.

State	Intend to Use Standard		Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Date Regulation Put In Place		Effective Date of Regulations		Additional Evaluation Required
	Standard 60	Standard 61				Standard 60	Standard 61	Standard 60	Standard 61	
Vermont	Yes	Yes	Yes	VWSR Ch.21 App. A §5.2.2	Yes	September 10, 1992	September 10, 1992	September 24, 1992	September 24, 1992	No
Virginia*	Yes	Yes	*Yes*[11]	VR 355-18-007.18 & *009.02*	Yes	*June 23, 1993*	*June 23, 1995*			No
Washington*	Yes	Yes	Policy		*Yes*	*September,1995 (expected)*	*September, 1995 (expected)*	*1996 (expected)*	*1996 (expected)*	*Yes*[12]
West Virginia*	Yes	Yes	Policy		Yes (policy)	*July, 1995*	*July, 1995*			No
Wisconsin	Yes	Yes	Yes	NR 811.07(4)(c), (f)	Yes	May 1, 1992	May 1, 1992	May, 1993	May, 1992	No
Wyoming	No	No								

[11] Currently using guidance.

[12] WA will check, in some instances, for quality of installation before initiating service.

APPENDIX B – NATIONAL PRIMARY DRINKING WATER STANDARDS

DRINKING WATER REGULATIONS

AND HEALTH ADVISORIES

by

Office of Water
U.S. Environmental Protection Agency
Washington, D.C.
202-260-7571

SAFE DRINKING WATER HOTLINE
1-800-426-4791
Monday thru Friday, 8:30 AM to 5:00 PM EST

May 1994

LEGEND

Abbreviations column descriptions are:

MCLG - Maximum Contaminant Level Goal. A non-enforceable concentration of a drinking water contaminant that is protective of adverse human health effects and allows an adequate margin of safety.

MCL - Maximum Contaminant Level. Maximum permissible level of a contaminant in water which is delivered to any user of a public water system.

RfD - Reference Dose. An estimate of a daily exposure to the human population that is likely to be without appreciable risk of deleterious effects over a lifetime.

DWEL - Drinking Water Equivalent Level. A lifetime exposure concentration protective of adverse, non-cancer health effects, that assumes all of the exposure to a contaminant is from a drinking water source.

(*) The codes for the Status Reg and Status HA columns are as follows:

F - final
D - draft
L - listed for regulation
P - proposed
T - tentative

Other codes found in the table include the following:

NA - not applicable
PS - performance standard 0.5 NTU - 1.0 NTU
TT - treatment technique

** - No more than 5% of the samples per month may be positive. For systems collecting fewer than 40 samples/month, no more than 1 sample per month may be positive.

*** - guidance

- Large discrepancies between Lifetime and Longer-term HA values may occur because of the Agency's conservative policies, especially with regard to carcinogenicity, relative source contribution, and less than lifetime exposures in chronic toxicity testing. These factors can result in a cumulative UF (uncertainty factor) of 10 to 1000 when calculating a Lifetime HA.

The scheme for categorizing chemicals according to their carcinogenic potential is as follows:

Group A: Human carcinogen

Sufficient evidence in epidemiologic studies to support causal association between exposure and cancer

Group B: Probable human carcinogen

Limited evidence in epidemiologic studies (Group B1) *and/or* sufficient evidence from animal studies (Group B2)

Group C: Possible human carcinogen

Limited evidence from animal studies *and* inadequate or no data in humans

Group D: Not classifiable

Inadequate or no human and animal evidence of carcinogenicity

Group E: No evidence of carcinogenicity for humans

No evidence of carcinogenicity in at least two adequate animal tests in different species *or* in adequate epidemiologic and animal studies

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
ORGANICS													
Acenaphthene	-	-	-	-	-	-	-	-	0.06	-	-	-	-
Acifluorfen	T	zero	*	F	2	2	0.1	0.4	0.013	0.4	*	0.1	B2
Acrylamide	F	zero	TT	F	0.2	0.2	0.01	0.04	0.001	0.04	-	0.001	B2
Acrylonitrile	T	zero	*	D	*	*	*	*	*	*	*	0.006	B1*
Adipate (diethylhexyl)	F	0.4	0.4	-	20	20	20	60	0.6	20	0.4	3	C
Alachlor	F	zero	0.002	F	0.1	0.1	*	*	0.01	0.4	*	0.04	B2
Aldicarb	D	0.007	0.007	D	-	-	-	-	0.001	0.035	0.007	-	D
Aldicarb sulfone	D	0.007	0.007	D	*	*	*	*	0.001	0.035	0.007	*	D
Aldicarb sulfoxide	D	0.007	0.007	D	-	-	-	-	0.001	0.035	0.007	-	D
Aldrin	*	*	*	D	0.0003	0.0003	0.0003	0.0003	0.00003	0.001	*	0.0002	B2
Ametryn	-	-	-	F	9	9	0.9	3	0.009	0.3	0.06	-	D
Ammonium sulfamate	*	*	*	F	20	20	20	80	0.28	8	2	*	D
Anthracene (PAH)	-	-	-	-	-	-	-	-	0.3	-	-	-	D
Atrazine	F	0.003	0.003	F	0.1	0.1	0.05	0.2	0.035	0.2*	0.003*	-	C
Baygon	-	-	-	F	0.04	0.04	0.04	0.1	0.004	0.1	0.003	-	C
Bentazon	T	0.02	*	F	0.3	0.3	0.3	0.9	0.0025	0.09	0.02	*	D
Benz(a)anthracene (PAH)	P	*zero*	*0.0001*	-	-	-	-	-	-	-	-	-	B2
Benzene	F	zero	0.005	F	0.2	0.2	*	*	*	*	*	0.1	A
Benzo(a)pyrene (PAH)	F	zero	0.0002	-	-	-	-	-	-	-	-	-	B2*
Benzo(b)fluoranthene (PAH)	P	zero	0.0002	-	-	-	-	-	-	-	-	-	B2
Benzo(g,h,i)perylene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	D
Benzo(k)fluoranthene (PAH)	P	zero	0.0002	-	-	-	-	-	-	-	-	-	B2
bis-2-Chloroisopropyl ether	-	-	-	F	4	4	4	13	0.04	1	0.3	-	D
Bromacil	L	-	-	F	5	5	3	9	0.13	5	0.09	-	C
Bromobenzene	L	-	-	D	-	-	-	-	-	-	-	-	-

* Under review.

NOTE: Anthracene and Benzo(g,h,i)perylene — not proposed in Phase V.

NOTE: Changes from the last version are noted in Italic and Bold Face print.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Bromochloroacetonitrile	L	-	-	D	-	-	-	-	-	-	-	-	-
Bromochloromethane	-	-	-	F	50	1	1	5	0.013	0.5	0.09	-	-
Bromodichloromethane (THM)	T	zero	*0.1*/0.08+*	D	7	7	4	13	0.02	0.7	-	0.06	B2
Bromoform (THM)	T	zero	*0.1*/0.08+*	D	5	2	2	6	0.02	0.7	-	0.4	B2
Bromomethane	T	-	-	F	0.1	0.1	0.1	0.5	0.001	0.04	0.01	-	D
Butyl benzyl phthalate (PAE)	P	zero	0.1	-	-	-	-	-	0.2	6	-	-	C
Butylate	-	-	-	F	2	2	1	4	0.05	2	0.35	-	D
Butylbenzene n-	-	-	-	D	-	-	-	-	-	-	-	-	-
Butylbenzene sec-	-	-	-	D	-	-	-	-	-	-	-	-	-
Butylbenzene tert-	-	-	-	D	-	-	-	-	-	-	-	-	-
Carbaryl	-	-	-	F	1	1	1	1	0.1	4	0.7	-	D
Carbofuran	F	0.04	0.04	F	0.05	0.05	0.05	0.2	0.005	0.2	0.04	-	E
Carbon tetrachloride	F	zero	0.005	F	4	0.2	0.07	0.3	0.0007	0.03	-	0.03	B2
Carboxin	-	-	-	F	1	1	1	4	0.1	4	0.7	-	D
Chloral hydrate	T	*0.04*	*0.06++*	D	7	1.4	0.2	0.6	0.0002	0.07	0.06	-	C
Chloramben	-	-	-	F	3	3	0.2	0.5	0.015	0.5	0.1	-	D
Chlordane	F	zero	0.002	F	0.06	0.06	-	-	0.00006	0.002	-	0.003	B2
Chlorodibromomethane (THM)	T	*0.06*	*0.1*/0.08+*	D	7	7	2	8	0.02	0.7	0.06	-	C
Chloroethane	L	-	-	D	-	-	-	-	-	-	-	-	-
Chloroform (THM)	T	zero	0.1*/0.08+	D	4	4	0.1	0.4	0.01	0.4	-	0.6	B2
Chloromethane	L	-	-	F	9	0.4	0.4	1	0.004	0.1	0.003	-	C
Chlorophenol (2-)	-	-	-	D	0.05	0.05	0.05	0.2	0.005	0.2	0.04	-	D
p-Chlorophenyl methyl sulfide/sulfone/sulfoxide	-	-	-	**	-	-	-	-	-	-	-	-	D
Chloropicrin	L	-	-	-	-	-	-	-	-	-	-	-	-
Chlorothalonil	-	-	-	F	0.2	0.2	0.2	0.5	0.015	0.5	-	0.15	B2
Chlorotoluene o-	L	-	-	F	2	2	2	7	0.02	0.7	0.1	-	D
Chlorotoluene p-	L	-	-	F	2	2	2	7	0.02	0.7	0.1	-	D
Chlorpyrifos	-	-	-	F	0.03	0.03	0.03	0.1	0.003	0.1	0.02	-	D
Chrysene (PAH)	P	zero	0.0002	-	-	-	-	-	-	-	-	-	B2
Cyanazine	T	0.001	-	D	0.1	0.1	0.02	0.07	0.002	0.07	0.001	-	C

* Current MCL + *Total for all THMs combined cannot exceed the 0.08 level.* ** Total for all haloacetic acids cannot exceed 0.06 level.

** A HA will not be developed due to insufficient data; a "Database Deficiency Report has been published.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Cyanogen chloride	L	-	-	-	-	-	-	-	-	-	-	-	-
Cymene p-	-	-	-	D	-	-	-	-	-	-	-	-	-
2,4-D	F	0.07	0.07	F	1	0.3	0.1	0.4	0.01	0.4	0.07	-	D
DCPA (Dacthal)	L	-	-	F	80	80	6	20	0.5	20	4	-	D
Dalapon	F	0.2	0.2	F	3	3	0.3	0.9	0.026	0.9	0.2	-	D
Di(2-ethylhexyl)adipate	F	0.4	0.4	-	20	20	20	60	0.6	20	0.4	3	C
Diazinon	-	-	-	F	0.02	0.02	0.005	0.02	0.00009	0.003	0.0006	-	E
Dibenz(a,h)anthracene (PAH)	P	zero	0.0003	-	-	-	-	-	-	-	-	-	B2
Dibromoacetonitrile	L	-	-	D	2	2	2	8	0.02	0.8	0.02	-	C
Dibromochloropropane (DBCP)	F	zero	0.0002	F	0.2	0.05	-	-	-	-	-	0.003	B2
Dibromomethane	L	-	-	-	-	-	-	-	-	-	-	-	D
Dibutyl phthalate (PAE)	-	-	-	-	-	-	-	-	0.1	4	-	-	D
Dicamba	L	-	-	F	0.3	0.3	0.3	1	0.03	1	0.2	-	D
Dichloroacetaldehyde	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloroacetic acid	T	zero	*0.06*++	D	1	1	1	4	*0.004*	0.1	-	-	B2
Dichloroacetonitrile	L	-	-	D	1	1	0.8	3	0.008	0.3	0.006	-	C
Dichlorobenzene o-	F	0.6	0.6	F	9	9	9	30	0.09	3	0.6	-	D
Dichlorobenzene m- *	F	0.6	0.6	F	9	9	9	30	0.09	3	0.6	-	D
Dichlorobenzene p-	F	0.075	0.075	F	10	10	10	40	0.1	4	0.075	-	C
Dichlorodifluoromethane	L	-	-	F	40	40	9	30	0.2	5	1	-	D
Dichloroethane (1,1-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloroethane (1,2-)	F	zero	0.005	F	0.7	0.7	0.7	2.6	-	-	-	0.04	B2
Dichloroethylene (1,1-)	F	0.007	0.007	F	2	1	1	4	0.009	0.4	0.007	-	C
Dichloroethylene (cis-1,2-)	F	0.07	0.07	F	4	3	3	11	0.01	0.4	0.07	-	D
Dichloroethylene (trans-1,2-)	F	0.1	0.1	F	20	2	2	6	0.02	0.6	0.1	-	D
Dichloromethane	F	zero	0.005	F	10	2	-	-	0.06	2	-	0.5	B2
Dichlorophenol (2,4-)	-	-	-	D	0.03	0.03	0.03	0.1	0.003	0.1	0.02	-	D
Dichloropropane (1,1-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropane (1,2-)	F	zero	0.005	F	-	0.09	-	-	-	-	-	0.05	B2
Dichloropropane (1,3-)	L	-	-	D	-	-	-	-	-	-	-	-	-

* The values for m-dichlorobenzene are based on data for o-dichlorobenzene.

++ Total for all haloacetic acids cannot exceed 0.06 level.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Dichloropropane (2,2-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropene (1,1-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropene (1,3-)	T	zero	-	F	0.03	0.03	0.03	0.09	0.0003	0.01	-	0.02	B2
Dieldrin	-	-	-	F	0.0005	0.0005	0.0005	0.002	0.00005	0.002	-	0.0002	B2
Diethyl phthalate (PAE)	-	-	-	D	-	-	-	-	0.8	30	5	-	D
Diethylene glycol dinitrate	-	-	-	**	-	-	-	-	-	-	-	-	-
Diethylhexyl phthalate (PAE)	F	zero	0.006	D	-	-	-	-	0.02	0.7	-	0.3	B2*
Diisopropyl methylphosphonate	-	-	-	F	8	8	8	30	0.08	3	0.6	-	D
Dimethrin	-	-	-	F	10	10	10	40	0.3	10	2	-	D
Dimethyl methylphosphonate	-	-	-	F	2	2	2	6	0.2	7	0.1	0.7	C
Dimethyl phthalate (PAE)	-	-	-	-	-	-	-	-	-	-	-	-	D
1,3-Dinitrobenzene	-	-	-	F	0.04	0.04	0.04	0.14	0.0001	0.005	0.001	-	D
Dinitrotoluene (2,4-)	L	-	-	F	0.50	0.50	0.30	1	0.002	0.1	-	-	-
Dinitrotoluene (2,6-)	L	-	-	F	0.40	0.40	0.40	1	0.001	0.04	-	-	-
tg 2,6 & 2,4 dinitrotoluene ***	-	-	-	-	-	-	-	-	-	-	-	0.005	B2
Dinoseb	F	0.007	0.007	F	0.3	0.3	0.01	0.04	0.001	0.04	0.007	-	D
Dioxane p-	-	-	-	F	4	0.4	-	-	-	-	-	0.7	B2
Diphenamid	-	-	-	F	0.3	0.3	0.3	1	0.03	1	0.2	-	D
Diphenylamine	-	-	-	F	1	1	0.3	1	0.03	1	0.2		D
Diquat	F	0.02	0.02	-	-	-	-	-	0.0022	0.08	0.02	-	D
Disulfoton	-	-	-	F	0.01	0.01	0.003	0.009	0.00004	0.001	0.0003	-	E
Dithiane (1,4-)	-	-	-	F	0.4	0.4	0.4	1	0.01	0.4	0.08	-	D
Diuron	-	-	-	F	1	1	0.3	0.9	0.002	0.07	0.01	-	D
Endothall	F	0.1	0.1	F	0.8	0.8	0.2	0.2	0.02	0.7	0.1	-	D
Endrin	F	0.002	0.002	F	0.02	0.02	0.003	0.01	0.0003	0.01	0.002	-	D
Epichlorohydrin	F	zero	TT	F	0.1	0.1	0.07	0.07	0.002	0.07	-	0.4	B2
Ethylbenzene	F	0.7	0.7	F	30	3	1	3	0.1	3	0.7	-	D
Ethylene dibromide (EDB)	F	zero	0.00005	F	0.008	0.008	-	-	-	-	-	0.00004	B2
Ethylene glycol	-	-	-	F	20	6	6	20	2	40	7	-	D
ETU	L	-	-	F	0.3	0.3	0.1	0.4	0.00008	0.003	-	0.03	B2
Fenamiphos	-	-	-	F	0.009	0.009	0.005	0.02	0.00025	0.009	0.002	-	D

* Under review. ** A HA will not be developed due to insufficient data; a "Database Deficiency Report" has been published.

*** tg = technical grade

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Fluometron	-	-	-	F	2	2	2	5	0.013	0.4	0.09		D
Fluorene (PAH)	-	-	-	-	-	-	-	-	0.04	-	-	-	D
Fluorotrichloromethane	L	-	-	F	7	7	3	10	0.3	10	2	-	D
Fog Oil	-	-	-	D	-	-	-	-	-	-	-	-	-
Fonofos	-	-	-	F	0.02	0.02	0.02	0.07	0.002	0.07	0.01	-	D
Formaldehyde	-	-	-	D	10	5	5	20	0.15	5	1	-	B1
Gasoline, unleaded (benzene)	-	-	-	D	-	-	-	-	-	-	0.005	-	-
Glyphosate	F	0.7	0.7	F	20	20	1	1	0.1	4	0.7	-	E
Heptachlor	F	zero	0.0004	F	0.01	0.01	0.005	0.005	0.0005	0.02	-	0.0008	B2
Heptachlor epoxide	F	zero	0.0002	F	0.01	-	0.0001	0.0001	1E-5	0.0004	-	0.0004	B2
Hexachlorobenzene	F	zero	0.001	F	0.05	0.05	0.05	0.2	0.0008	0.03	-	0.002	B2
Hexachlorobutadiene	T	0.001	-	F	0.3	0.3	0.1	0.4	0.002	0.07	0.001	-	C
Hexachlorocyclopentadiene	F	0.05	0.05	-	-	-	-	-	0.007	0.2	-	-	D
Hexachloroethane	L	-	-	F	5	5	0.1	0.5	0.001	0.04	0.001	-	C
Hexane (n-)	-	-	-	F	10	4	4	10	-	-	-	-	D
Hexazinone	-	-	-	F	3	3	3	9	0.033	1	0.2	-	D
HMX	-	-	-	F	5	5	5	20	0.05	2	0.4	-	D
Indeno(1,2,3,-c,d)pyrene (PAH)	P	zero	0.0004	D	-	-	-	-	-	-	-	-	B2
Isophorone	L	-	-	F	15	15	15	15	0.2	7	0.1	4	C
Isopropyl methylphosphonate	-	-	-	D	30	30	30	100	0.1	4.0	0.7	-	D
Isopropylbenzene	-	-	-	D	-	-	-	-	-	-	-	-	-
Lindane	F	0.0002	0.0002	F	1	1	0.03	0.1	0.0003	0.01	0.0002	-	C
Malathion	-	-	-	F	0.2	0.2	0.2	0.8	0.02	0.8	0.2	-	D
Maleic hydrazide	-	-	-	F	10	10	5	20	0.5	20	4	-	D
MCPA	-	-	-	F	0.1	0.1	0.1	0.4	0.0015	0.05	0.01	-	E
Methomyl	L	-	-	F	0.3	0.3	0.3	0.3	0.025	0.9	0.2	-	D
Methoxychlor	F	0.04	0.04	F	0.05	0.05	0.05	0.2	0.005	0.2	0.04	-	D
Methyl ethyl ketone	-	-	-	F	-	-	-	-	-	-	-	-	*
Methyl parathion	-	-	-	F	0.3	0.3	0.03	0.1	0.00025	0.009	0.002	-	D

* Under review.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Methyl tert butyl ether	L	-	-	D	3	3	0.5	2	0.005	0.2	0.04	-	D
Metolachlor	L	-	-	F	2	2	2	5	0.15	5	0.1	-	C
Metribuzin	L	-	-	F	5	5	0.3	0.9	0.025	0.9	0.2	-	D
Monochloroacetic acid	L	-	-	D	-	-	-	-	-	-	-	-	-
Monochlorobenzene	F	0.1	0.1	F	2	2	2	7	0.02	0.7	0.1	-	D
Naphthalene	-	-	-	F	0.5	0.5	0.4	1	0.004	0.1	0.02	-	D
Nitrocellulose (non-toxic)	-	-	-	F	-	-	-	-	-	-	-	-	-
Nitroguanidine	-	-	-	F	10	10	10	40	0.1	4	0.7	-	D
Nitrophenol p-	-	-	-	F	0.8	0.8	0.8	3	0.008	0.3	0.06	-	D
Oxamyl (Vydate)	F	0.2	0.2	F	0.2	0.2	0.2	0.9	0.025	0.9	0.2	-	E
Paraquat	-	-	-	F	0.1	0.1	0.05	0.2	0.0045	0.2	0.03	-	E
Pentachloroethane	-	-	-	D	-	-	-	-	-	-	-	-	-
Pentachlorophenol	F	zero	0.001	F	1	0.3	0.3	1	0.03	1	-	0.03	B2
Phenanthrene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	D	6	6	6	20	0.6	20	4	-	D
Picloram	F	0.5	0.5	F	20	20	0.7	2	0.07	2	0.5	-	D
Polychlorinated biphenyls (PCBs)	F	zero	0.0005	P	-	-	-	-	-	-	-	0.0005	B2
Prometon	L	-	-	F	0.2	0.2	0.2	0.5	0.015*	0.5*	0.1*	-	D
Pronamide	-	-	-	F	0.8	0.8	0.8	3	0.075	3	0.05	-	C
Propachlor	-	-	-	F	0.5	0.5	0.1	0.5	0.013	0.5	0.09	-	D
Propazine	-	-	-	F	1	1	0.5	2	0.02	0.7	0.01	-	C
Propham	-	-	-	F	5	5	5	20	0.02	0.6	0.1	-	D
Propylbenzene n-	-	-	-	D	-	-	-	-	-	-	-	-	-
Pyrene (PAH)	-	-	-	-	-	-	-	-	0.03	-	-	-	D
RDX	-	-	-	F	0.1	0.1	0.1	0.4	0.003	0.1	0.002	0.03	C
Simazine	F	0.004	0.004	F	0.07	0.07	0.07	0.07	0.005	0.2	0.004	-	C
Styrene	F	0.1	0.1	F	20	2	2	7	0.2	7	0.1	-	C
2,4,5-T	L	-	-	F	0.8	0.8	0.8	1	0.01	0.35	0.07	-	D
2,3,7,8-TCDD (Dioxin)	F	zero	3E-08	F	1E-06	1E-07	1E-08	4E-08	1E-09	4E-08	-	2E-08	B2

* Under review. NOTE: Phenanthrene — not proposed.

Drinking Water Standards and Health Advisories

Chemicals	Standards				Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)	Status HA	One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Tebuthiuron	-	-	-	F	3	3	0.7	2	0.07	2	0.5	-	D
Terbacil	-	-	-	F	0.3	0.3	0.3	0.9	0.013	0.4	0.09	-	E
Terbufos	-	-	-	F	0.005	0.005	0.001	0.005	0.00013	0.005	0.0009	-	D
Tetrachloroethane (1,1,1,2-)	L	-	-	F	2	2	0.9	3	0.03	1	0.07	0.1	C
Tetrachloroethane (1,1,2,2-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	F	zero	0.005	F	2	2	1	5	0.01	0.5	-	0.07	-
Tetranitromethane	-	-	-	**	-	-	-	-	-	-	-	-	-
Toluene	F	1	1	F	20	2	2	7	0.2	7	1	-	D
Toxaphene	F	zero	0.003	F	0.5	0.04	-	-	0.1	0.0035	-	0.003	B2
2,4,5-TP	F	0.05	0.05	F	0.2	0.2	0.07	0.3	0.0075	0.3	0.05	-	D
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroacetic acid	T	*0.3*	*0.06***	D	4	4	4	13	0.1	4.0	0.3	-	C
Trichloroacetonitrile	L	-	-	D	0.05	0.05	-	-	-	-	-	-	-
Trichlorobenzene (1,2,4-)	F	0.07	0.07	F	0.1	0.1	0.1	0.5	0.01	0.4	0.07	-	D
Trichlorobenzene (1,3,5-)	-	-	-	F	0.6	0.6	0.6	2	0.006	0.2	0.04	-	D
Trichloroethane (1,1,1-)	F	0.2	0.2	F	100	40	40	100	0.035	1	0.2	-	D
Trichloroethane (1,1,2-)	F	0.003	0.005	F	0.6	0.4	0.4	1	0.004	0.1	0.003	-	C
Trichloroethanol (2,2,2-)	L	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene	F	zero	0.005	F	-	-	-	-	-	0.3	-	0.3	B2
Trichlorophenol (2,4,6-)	L	-	-	D	-	-	-	-	-	-	-	0.3	B2
Trichloropropane (1,1,1-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trichloropropane (1,2,3-)	L	-	-	F	0.6	0.6	0.6	2	0.006	0.2	0.04	-	B2
Trifluralin	L	-	-	F	0.08	0.08	0.08	0.3	0.0075	0.3	0.005	0.5	C
Trimethylbenzene (1,2,4-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trimethylbenzene (1,3,5-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trinitroglycerol	-	-	-	F	0.005	0.005	0.005	0.005	-	-	0.005	-	-
Trinitrotoluene	-	-	-	F	0.02	0.02	0.02	0.02	0.0005	0.02	0.002	0.1	C
Vinyl chloride	F	zero	0.002	F	3	3	0.01	0.05	-	-	-	0.0015	A
Xylenes	F	10	10	F	40	40	40	100	2	60	10	-	D

** A HA will not be developed due to insufficient data; a "Database Deficiency Report" has been published.

*** Total for all haloacetic acids cannot exceed 0.06 level.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
INORGANICS													
Aluminum	L	-	-	D	-	-	-	-	-	-	-	-	-
Ammonia	-	-	-	D	-	-	-	-	-	-	30	-	D
Antimony	F	0.006	0.006	F	0.01	0.01	0.01	0.015	0.0004	0.01	0.003	-	D
Arsenic	*	-	0.05	D	-	-	-	-	-	-	-	0.002	A
Asbestos (fibers/l >10μm length)	F	7 MFL	7 MFL	-	-	-	-	-	-	-	-	700 MFL	A
Barium	F	2	2	F	-	-	-	-	0.07	2	2	-	D
Beryllium	F	0.004	0.004	D	30	30	4	20	0.005	0.2	-	0.0008	B2
Boron	L	-	-	D	4	0.9	0.9	3	0.09	3	0.6	*	D
Bromate	*L*	*zero*	*0.01*	-	-	-	-	-	-	-	-	-	-
Cadmium	F	0.005	0.005	F	0.04	0.04	0.005	0.02	0.0005	0.02	0.005	-	D
Chloramine	T	*4****	*4*	D	1	1	1	1	0.1	3.3	*3/4****	-	-
Chlorate	L	-	-	D	-	-	-	-	-	-	-	-	-
Chlorine	T	4	*4*	D	-	-	-	-	0.08	-	-	-	D
Chlorine dioxide	T	*0.3*	*0.8*	D	-	-	-	-	*0.01*	*0.35*	*0.3*	-	D
Chlorite	L	*0.08*	*1*	D	-	-	-	-	*0.003*	*0.1*	*0.08*	-	D
Chromium (total)	F	0.1	0.1	F	1	1	0.2	0.8	0.005	0.2	0.1	-	D
Copper	F	1.3	TT**	-	-	-	-	-	-	-	-	-	D
Cyanide	P	0.2	0.2	F	0.2	0.2	0.2	0.8	0.022	0.8	0.2	-	D
Fluoride*	F	4	4	-	-	-	-	-	0.12	-	-	-	-
Hypochlorite	T	*4*[1]	-	-	-	-	-	-	-	-	-	-	-
Hypochlorous acid	T	*4*[1]	-	-	-	-	-	-	-	-	-	-	-
Lead (at tap)	F	zero	TT**	-	-	-	-	-	-	-	-	-	B2
Manganese	L	-	-	D	-	-	-	-	0.14/0.005	-	-	-	-
Mercury (inorganic)	F	0.002	0.002	F	-	-	-	0.002	0.0003	0.01	0.002	-	D
Molybdenum	L	-	-	D	-	0.08	0.01	0.05	0.005	0.2	0.04	-	D
Nickel	F	0.1	0.1	F	1	1	0.5	1.7	0.02	0.6	0.1	-	D
Nitrate (as N)	F	10	10	F	-	10*	-	-	1.6	-	-	-	*

* Under review. ** Copper — action level 1.3 mg/L; Lead - action level 0.015 mg/L. *** Measured as free chlorine. [1] Regulated as chlorine.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Nitrite (as N)	F	1	1	F	-	1*	-	-	0.16*	-	-	-	*
Nitrate + Nitrite (both as N)	F	10	10	F	-	-	-	-	-	-	-	-	*
Selenium	F	0.05	0.05	-	-	-	-	-	0.005	-	-	-	-
Silver	-	-	-	D	0.2	0.2	0.2	0.2	0.005	0.2	0.1	-	D
Sodium	-	-	-	D	-	-	-	-	-	20***	-	-	-
Strontium	L	-	-	D	25	25	25	90	0.6	90	17	-	D
Sulfate	P	**	**	-	-	-	-	-	-	-	-	-	-
Thallium	F	0.0005	0.002	F	0.007	0.007	0.007	0.02	0.00007	0.002	0.0004	-	-
Vanadium	L	-	-	D	-	-	-	-	-	-	-	-	D
White phosphorous	-	-	-	F	-	-	-	-	0.00002	0.0005	0.0001		D
Zinc	L	-	-	F	6	6	3	12	0.3	11	2	-	D
Zinc chloride (measured as Zinc)	L	-	-	F	6	6	3	12	0.3	11	2	-	D
RADIONUCLIDES													
Beta particle and photon activity (formerly man-made radionuclides)	P	zero	4 mrem		<50 pCi/L per Elaine Brown Leo Huebner			-	-	-	-	4 mrem/y	A
Gross alpha particle activity	P	zero	15 pCi/L	-	-	-	-	-	-	-	-	15 pCi/L	A
Radium 226	P	zero	20 pCi/L	-	-	-	-	-	-	-	-	20 pCi/L	A
Radium 228	P	zero	20 pCi/L	-	-	-	-	-	-	-	-	20 pCi/L	A
Radon	P	zero	300 pCi/L	-	-	-	-	-	-	-	-	150 pCi/L	A
Uranium	P	zero	20 µg/L	-	-	-	-	-	0.003	-	-	*	A

* Under review.

** Deferred.

*** Guidance.

Secondary Maximum Contaminant Levels

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Chemicals	Status	SMCLs (mg/L)
Aluminum	F	0.05 to 0.2
Chloride	F	250
Color	F	15 color units
Copper	F	1.0
Corrosivity	F	non-corrosive
Fluoride*	F	2.0
Foaming agents	F	0.5
Iron	F	0.3
Manganese	F	0.05
Odor	F	3 threshold odor numbers
pH	F	6.5 — 8.5
Silver	F	0.1
Sulfate	F	250
Total dissolved solids (TDS)	F	500
Zinc	F	5

Status Codes: P — proposed, F — final

* Under review.

[illegible]	Status	MCLG	MCL
Cryptosporidium	L	-	-
Giardia lamblia	F	zero	TT
Legionella	F[β]	zero	TT
Standard Plate Count	F[β]	NA	TT
Total Coliforms (after 12/31/90)	F	zero	**
Turbidity (after 12/31/90)	F	NA	PS
Viruses	F[β]	zero	TT

Key: PS, TT, F, defined as previously stated.

[β] Final for systems using surface water; also being considered for regulation under groundwater disinfection rule.

APPENDIX C – GUIDANCE DOCUMENT FOR CEMENT COMPANIES PREPARING ANSI/NSF 61 APPLICATIONS FOR NSF INTERNATIONAL

GUIDANCE DOCUMENT FOR CEMENT COMPANIES PREPARING ANSI/NSF 61 APPLICATIONS FOR SUBMISSION TO NSF INTERNATIONAL*

Overview of Formulation Review

NSF Toxicology Data Review Submission Forms (TDRS-Form A and TDRS-Form B) are the basis for the toxicological review. The procedure is for a cement producer to first complete the A-Form for each unique product at each plant. Some of these A-Forms may be followed by an NSF request for a vendor (supplier to a cement producer) to complete a TDRS-Form B. Typically, B-Forms will go to vendors such as grinding aid suppliers and waste fuel blenders These forms must be completed and signed by the vendors. Occasionally, NSF staff may request a "B-on-a-B" which means that a company supplying materials to one of your vendors may have to provide additional information. The B-Forms are controlled documents that NSF cannot issue until after reviewing the A-Form. Each B-Form is numbered and tied to a registered A-Form for tracking purposes.

We have been told that obtaining B-Forms from vendors often is the slowest step in the whole process of ANSI/NSF 61 certification,. Therefore, we suggest that you contact vendors likely to be queried by NSF and inform them you will need information such as Material Safety Data Sheets and product formulations.

When all B-Forms have been received by NSF, the Formulation Review is performed over approximately two weeks. The toxicologist determines which analyses are to be performed by NSF and its subcontract labs. For cement, nearly all raw materials are considered by the toxicologists to be geological in origin; therefore, all cements will have their mortar extraction waters tested for metals and for gross alpha and gross beta levels. If gross alpha or gross beta counts are significant, the toxicologist will have determinations performed for specific radionuclides. Requesting the radionuclides be determined initially might be an unnecessary expense so that will not be done unless gross counts are high. This additional testing will require additional time.

Since cements are produced through pyroprocessing, and some chlorine is probably present in any kiln system, the toxicologists will likely request that dioxins and furans be determined in the extraction waters. Testing for other organic compounds will depend on grinding aids used and possible sources of organic contaminants. Alternate raw materials or waste-derived fuels might merit additional analyses of the cement mortar cube extraction waters. In some cases, NSF labs might have to develop or refine analytical methods to provide the toxicologist with specific data. Such methods development work will take additional time.

Toxicology Data Review Submission (TDRS)-Form A

This is the first form. It is an uncontrolled document sent to you by NSF International in the application packet. On the TDRS-Form A you will provide information about the raw materials and properties of the cement that you are submitting for certification. This form is used for several types of products and only certain sections must be completed for cements.

I. Identification Information

Fill in blanks with 1) name of your company, 2) name of person who will be your company's technical contact with NSF, 3) that person's phone, fax, and address. Fill in blanks with the cement plant's name, mailing and

---

* This Guidance Document was prepared by Construction Technology Laboratories under contract to the Portland Cement Association. This document is intended for use by cement companies submitting samples to NSF International for ANSI/NSF 61 certification testing. Readers should be aware that other independent companies may offer certification testing. This document does not imply Portland Cement Association endorsement of the services of specific certification organizations.

shipping addresses, phone and fax numbers. In the blank for plant contact name, we suggest that you insert the plant manager's name.

II. Product Information

1. Product Name/Trade Designation - Enter the brand name and ASTM Type.
2. Category Code - Enter "PMTL" indicating protective material to be tested under Section 5 of ANSI/NSF 61. For Function Code, enter "CMT" for cement.
3. Temperature - Check "cold"
4, 5, 6, 7. Not applicable, leave blank.
8. Waste derived fuels or materials - If your facility handles hazardous waste according to RCRA definitions (40 CFR 261.3), check "yes" and specify in III.
9. Post kiln processing aids should be identified here and on III.
10. Indicate the specified end use for your product, if known.
11. Not applicable, leave blank.

III. Formulation Information

On this form you will list the raw materials used to make your clinker, as well as processing aids and functional additions used to make the cement. Alternate sources of raw materials, as well as gypsum and grinding aids, must be listed here. Waste materials burned with the raw feed that are not fuels must be listed here. Do not list on this form your standard or alternate fuels, or waste materials burned as fuel. List all the major clinker raw materials first, followed by alternate raw materials, followed by ingredients such as gypsum/anhydrite (or pozzolans for blended cements), followed by processing aids.

Under *Chemical Abstract Registry Number* list the CAS number corresponding best to the raw material or additive. CAS numbers can be obtained by searching a database such as STN Registry. CAS numbers for selected materials are listed here:

Material	CAS Number	Material	CAS Number
limestone	1317-65-3	spent nickel catalyst	85203-91-4
calcite, $CaCO_3$	13397-26-7	staurolite	63043-12-9
dolomite, $CaMg(CO_3)_2$	16389-88-1	gypsum, $CaSO_4 \cdot 2H_2O$	13397-24-5
iron source, Fe	7439-89-6	plaster, $CaSO_4 \cdot 1/2H_2O$	26499-65-0
quartz sand, SiO_2	14808-60-7	anhydrite, $CaSO_4$	14798-04-0
coal fly ash	71243-67-9	clay	1302-87-0
bottom ash	68131-74-8	kaolin (white clay)	1332-58-7
bauxite	1318-16-7	illitic clays	63393-88-4
mill scale	65996-74-9	kaolinitic clays	71888-52-3
diatomaceous earth	61790-53-2		
laterite	12211-33-5		
waste oil shale	93685-99-5	portland cement	65997-15-1
blast furnace slag	65996-69-2	cement kiln dust	68475-76-3

Under *Chemical Name* list the chemical formula corresponding generally to the composition of the individual material. Examples:

Limestone: $CaCO_3$ with traces of SiO_2, $MgCO_3$
Iron ore: Fe_2O_3 with trace quartz
Class F Fly ash: silicate glass with traces of carbon, quartz, mullite, hematite

Under *Trade Name* list the commercial descriptions of materials. For quarried materials from your property, use the common name such as "High rock" or "Level 3 shale." Names of purchased materials should match the names or descriptions shown on your vendors' invoices.

Under the column headed *I, R, P* indicate whether a material is an ingredient (gypsum or blended component such as fly ash or slag), a reactant (all raw materials are reactants), or a processing aid (grinding aid, dust suppressant, water spray, etc.).

Under *Composition* indicate the weight percent of the material in the finished product cement. The total of all standard raw materials and ingredients should add up to 100%. For alternate materials, indicate which standard raw materials they replace.

Under *Code of Federal Regulations (CFR)* place a check to indicate if the material is listed in 21CFR Sections 172, 182, 184, or 185. These sections list U. S. Food and Drug Administration Approved substances. Leave this column blank if you are not sure whether any particular material is FDA approved; NSF staff can determine.

IV. Production and Chemical Information

1. Manufacturing process – Check the box marked *other* and write "pyroprocessing" in the blank.

2. Recycled materials – Check the blank marked *YES* if you use recycled or reprocessed materials. Attach as much information as you have available about the sources and composition of these materials. Describe how these materials are fed into the manufacturing process.

3. Single/multiple use – Check the box marked *Single use* . Separate TDRS-A forms will be provided for portland, masonry, and blended cements.

4. Impurities – Under the column headed *Chemical Name* list fuels including your standard fuel, alternate fuels, and any waste-derived fuels. Under *Amount % or ppm* list the amount of ash from the fuel that ends up in the cement on a weight percent basis. Do not give the fuel feed rate, such as tons per hour. Example: If you feed 400 lb coal/ ton clinker and the coal has 5% ash content, you would have (0.05 x 400 lb/2000 lb) x 100% = 1% ash in the clinker. (Further "dilution" of the clinker with gypsum, say 2.5% as SO_3, is negligible.)

Under the column *CAS#* enter the Chemical Abstracts Service registry number for the fuel. Common CAS numbers are:

bituminous coal	125612-26-2
petroleum coke	64741-79-3
natural gas	8006-14-2
carbon	7440-44-0

Leave the column headed *Analytical Method* blank.

V. Migration/Extraction Information

Leave this section blank.

VI. Health Effects

Check the box indicating *no knowledge* of toxicity data. Check the box indicating *no literature search* will be performed by your company. (NSF will have this information on file for cements in general and will build their database with information about cement-making materials.)

VII. Attachments

Attach the following documents:

- Mill test certificates
- Analyses of waste materials used in the manufacturing process
- Any ANSI/NSF 61 test results

VII. Certification Statement

Sign and fill in the blanks with the name shown in Part I.

TOXICOLOGY DATA REVIEW SUBMISSION (TDRS)-FORM A
NSF *International* (NSF)
FOR ASSISTANCE: 1-800-252-6010 or 313-769-8010
From 9am to 4pm Eastern Time

NSF USE ONLY
Standard_____
Document Control Code (DCC):_____
Company No.:_____
Accepted By:_____
Date of Certification:_____

STANDARD 61: DRINKING WATER SYSTEM COMPONENTS

Section 6: Joining and Sealing Materials
Section 7: Process Media
Plastic Materials
Generic Ingredients (Standard 14 only)
PPI/PVC Range Formula Ingredients (Standard 14 only)
Portland Cement/Cement and Admixtures

(CONFIDENTIAL INFORMATION)

I. IDENTIFICATION INFORMATION

Company name _____ Company contact _____

Address _____ Telephone number ( )_____

_____ FAX number ( )_____

_____

_____

IMPORTANT: If the product formulation is identical and the product is manufactured at more than one plant location, add as an attachment to this form a list of plant addresses and a plant contact for each site. If the formulation is different in any way, for multiple plant locations, a form must be completed for each plant.

Plant name _____ Plant contact_____

Address _____ Telephone number ( )_____

_____ FAX number ( )_____

_____

II. PRODUCT INFORMATION

1. Product Name/Trade Designation _____

   Additional Names/Designations for Same Product _____

   _____

   _____

2. Indicate category code and function code for product (see instruction sheet for codes). If more than one category or function please complete a separate form for each category and/or function.

   Category Code_____ Function Code_____

3. For Portland Cements, Admixtures, Joining and Sealing Materials, and Plastic Materials indicate the maximum water temperature to which your product or material can be subjected under normal operating conditions. (Process Media is evaluated at cold only.)

☐ Cold (78°F/23°C) ☐ Domestic hot (140°F/60°C) ☐ Commercial hot (180°F/82°C)

4. For Plastic Materials, indicate end use.

a. ☐ Pipe ☐ Fittings ☐ Other _____

Standard 61 Applicants Only

5. Indicate size range or surface area-to-volume ratio of product for which Certification is being requested in in^2/gallon or cm^2/liter

_____

Plastic Material Applicants Only

6. Indicate Compounder Classification

a. ☐ Material Supplier ☐ In-Plant Compound (proceed to part b) ☐ Special Compounder

b. If you are an in-plant compounder list formulation source (if transferred)

_____

7. Indicate cell class, type and grade.

Cell Class _____

Type & Grade _____

ASTM Reference _____

Portland Cements and Admixtures Applicants Only

8. Are waste derived fuels and/or raw materials used in the generation of this cement?

Yes ☐ No ☐

9. Are grinding aids or other post kiln processing aids used in the manufacture of the cement?

Yes ☐ No ☐

If yes, identify on page 3 of 6.

10. Is there a specific end use for the cement manufactured here or can it be used for any application?

Tanks/Reservoirs ☐ Pipe/Fittings ☐ Any Application ☐

Cementitious Coatings ☐ Grout/Patching Compound ☐ Other ☐

Water contact surface area to volume ratio? _____ in^2/gallon(liter)

11. List maximum use of admixtures _____.

III. FO. LATION INFORMATION: (All information documented is held in : confidence.)

List the formulation and related information as follows:

Chemical Abstract Service Number (CAS No.)	Chemical Name	Trade Name	Supplier(s) (Include Alternate Suppliers)	I,R,P*	Composition		TDRS-B Info (NSF Use Only)
					%	Parts by Weight (PHR)	

*Indicate whether an ingredient (I) or Reactant (R) or Processing Aid (P).

IV. PRODUCTION AND CHEMICAL INFORMATION

1. Is the product _____ mined or _____ manufactured?

   a. If mined, is it purified? YES ___ NO ___
   If YES, how?_____
   Is it ground or mixed to a homogeneous mixture? YES ___ NO ___

   b. If manufactured or synthesized, provide the following:
   Please provide separate attachments as necessary.

   Manufactured:
   1. How is the product manufactured?

      ☐ blended (compounded) ☐ vulcanized
      ☐ extruded ☐ other_____
      ☐ compression/injection molded

   Synthesized:
   1. Recognized name of synthesis:_____
   2. Purification procedure_____
   3. Provide the analytical procedure for the analysis of your product. Provide either a literature reference or a written procedure_____
   4. Molecular weight (molecular weight distribution for polymers)_____
   5. Itemize the reaction products of initiators, stabilizers, and catalysts used in the manufacture or synthesis of your product.

2. Are any recycled or reprocessed materials used in this product? ___ YES ___ NO. If yes, provide a separate attachment describing how impurities and lot-to-lot variations are controlled.

3. How is the product handled/packaged? ☐ Single use (dedicated) system. ☐ Multiple use (non-dedicated) system.

   If multiple products are handled, list other products handled.

   _____ _____
   _____ _____
   _____ _____

4. Itemize below, known or suspected impurities in the finished product including, but not limited to, unreacted starting materials, by-products, low molecular weight polymers, etc. If available, provide literature reference(s) or written procedure(s) for the identification of impurities in your product and starting materials.

Chemical Name	Amount % or ppm	CAS #	Analytical Method

V. MIGRATION/EXTRACTION INFORMATION

1. Have tests been run on your product to determine migration/extraction levels of the MATERIAL, CONTAMINANTS or IMPURITIES from your product into water? ___ YES ___ NO

   If the answer is yes, please append the complete report(s) for every component or impurity studied, including a copy of the analytical method or a literature reference to the method.

VI. HEALTH EFFECTS

Analysis of the Applicant's product will be conducted to identify potential contaminants to the drinking water. Laboratory values of contaminant concentrations will be normalized to "at-the-tap" values. Those contaminants for which the Environmental Protection Agency has not established a Maximum Contaminant Level (MCL) may require additional toxicity testing according to the guidelines of ANSI/NSF Standards 60/61, Appendix A. Information you provide (as attachments to this form) regarding your knowledge of specific toxicology studies will expedite the applicant's Certification and may alleviate the need for additional toxicity testing.

1. Toxicology Studies: As an attachment to this form, please provide a detailed list of all known published and unpublished toxicology studies (acute, subchronic, chronic, mutagenicity, teratogencity, reproductive, carcinogenicity, epidemiology, etc.) relevant to your product, materials, ingredients, and/or impurities. For each reference include:

   a. Name of specific material, ingredient, or impurity addressed by the study.
   b. Type of study (Ames, Sister Chromatid Exchange, etc.).
   c. Complete reference: (author[s], title, source, volume, pages, year).
   d. Summary of study results (include ALL treatment-related effects; provide your opinion, with justification, for any results you feel should be discounted; attach complete reports, if desired).

___ (Check if no knowledge of toxicity data exists within your company related to this Listing application).

2. A toxicology literature search provided by your company may expedite the toxicology review and minimize costs to the applicant for obtaining toxicology data. For each literature search appended to this form, itemize as described below:

Database	_____	_____	_____
File #	_____	_____	_____
Keywords	_____	_____	_____
Date	_____	_____	_____

___ (Check if no literature search has been, or will be, conducted by your company.)

VII. ATTACHMENTS

List attachments to this form _____ No. of Pages _____

_____ _____

_____ _____

_____ _____

_____ _____

VIII. CERTIFICATION STATEMENT:

I hereby certify that the information provided is accurate and complete, and that I, and the Company I represent, know of no reason the product/material described herein should not be used in contact with drinking water.

Signature _____ Date _____

Typed or printed name _____

Position/Title _____

Company _____

Phone (___)_____ FAX (___)_____

The following authorization is OPTIONAL. It in no way authorizes NSF to share the information with other Applicants. Authorized NSF staff ONLY will be allowed access to this information. By completing this authorization, this Form A may be used to support the referenced ingredient/material/product as part of another applicant's package.

I give NSF permission to use the information contained in this TDRS Form A as a basis for reviewing/accepting other products which use this specific ingredient/material/product covered by this application.

Optional Authorization_____ Date_____

IX. RETURN INSTRUCTIONS:

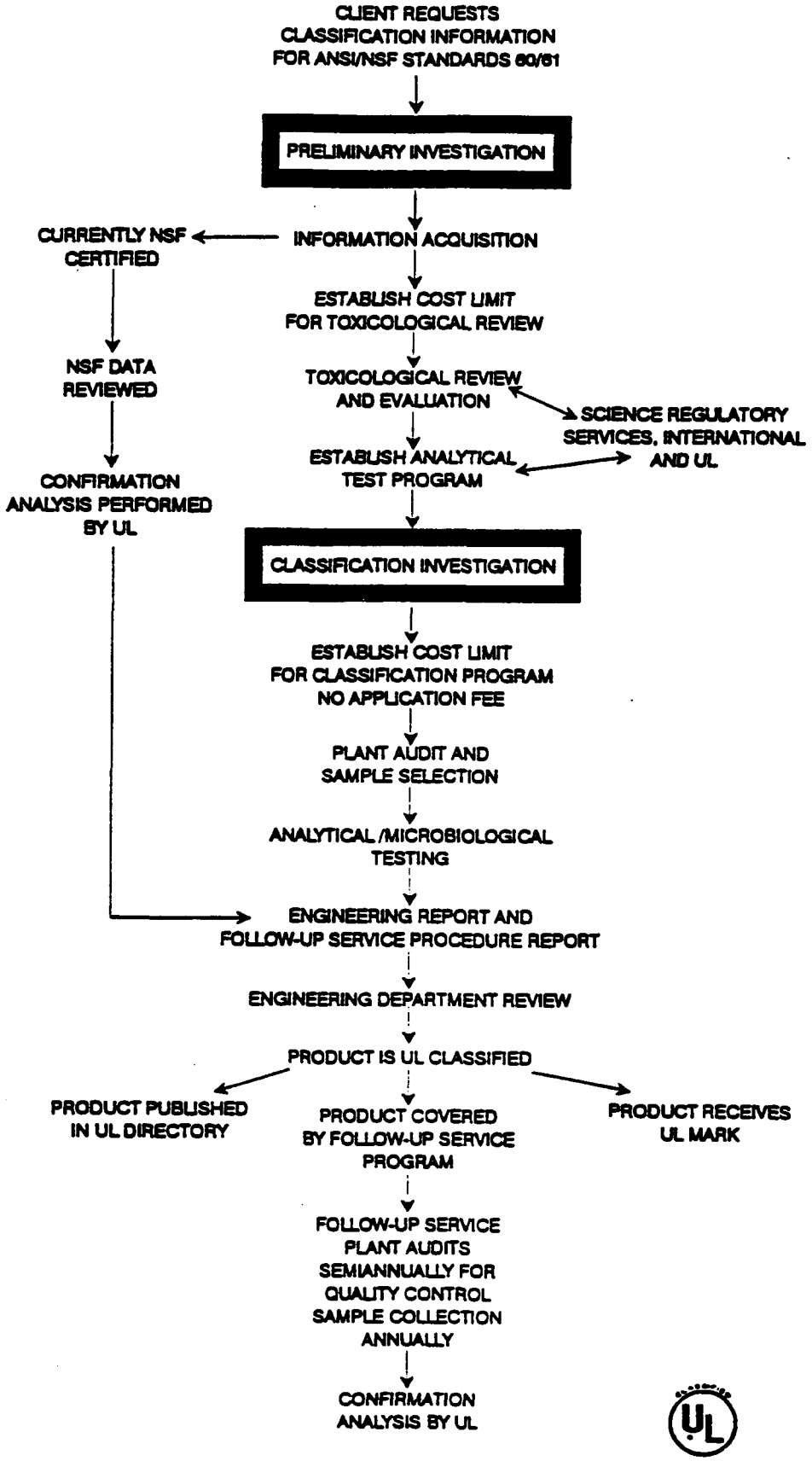
WHERE TO MAIL? INSERT COMPLETED FORM IN AN ENVELOPE MARKED "CONFIDENTIAL BUSINESS INFORMATION", SEAL IN AN OUTER ENVELOPE, AND RETURN TO:

VIA U.S. MAIL:
Additives Toxicology Group
NSF *International*
P.O. Box 130140
Ann Arbor, MI 48113-0140

VIA COURIER SERVICE:
Additives Toxicology Group
NSF *International*
3475 Plymouth Road
Ann Arbor, MI 48105

APPENDIX D – UNDERWRITERS LABORATORIES APPLICATION FORMS

DIRECT AND INDIRECT WATER ADDITIVES PROGRAM
UNDERWRITERS LABORATORIES, INC.



333 Pfingsten Road
Northbrook, Illinois 60062-2096
(708) 272-8800
FAX No. (708) 272-8129
MCI Mail No. 254-3343
Telex No. 6502543343

Underwriters Laboratories Inc.®

CLASSIFICATION INFORMATION FOR ANSI/NSF STANDARD 61

FORM 1 To be completed by the applicant. A copy of FORM 2 must be completed by the supplier of each ingredient, catalyst, reactant, etc. in the applicant's product.

Please return completed form to:

Underwriters Laboratories Inc.
Attn:
333 Pfingsten Road
Northbrook, IL 60062

UL will refrain, without your prior written authorization, from voluntarily disclosing to third parties secret information which is obtained by the Laboratories in confidence from you and which is not already known to the Laboratories, already available to the public or subsequently acquired from other sources.

Applicant's Name _____

Applicant's Address _____

_____

Name and Telephone Number of Applicant's Contact

_____

_____

Name and Address of All Manufacturing Sites to be Listed

_____

_____

_____

_____

_____

_____

PRODUCT INFORMATION

1. Product Name, Trade Name, Model Number and Product Line Size Range (where applicable)

_____

_____

2. Product Category

Check One:

____ Pipe and Related Fittings
____ Protective (Barrier) Materials
____ Joining and Sealing Materials
____ Process Media
____ Mechanical Devices
____ Mechanical Plumbing Products

3. Product Function _____

_____

4. Method of Manufacture. Give a brief description of the manufacturing process for this product including chemical reactions (where applicable).

_____

_____

_____

5. Product Composition and Manufacturing Aids. List all materials, ingredients, catalysts, processing aids, etc. involved in the manufacture of this product, as well as their respective suppliers. If there is more than one supplier for each given material, list each separately.

Trade Name	Chemical Description and Formula	CAS. NO.	Function (Ingredient, Catalyst, Etc.)	Parts By Weight In Final Product	Supplier

SUPPLIER INFORMATION

Name of Supplier	Address	Telephone No.	Contact Name

CONTAMINANT INFORMATION

1. List all known and suspected contaminants/impurities imparted to drinking water by the product and/or by its manufacturing process and their concentrations in the water, if known.

_____

_____

_____

_____

2. List the total surface area of the product that is in contact with water and the volume of water in contact with the product under static conditions. (If the product has various sizes, please provide the data that provides the largest surface area to volume ratio.)

_____

TOXICOLOGY INFORMATION

1. List all toxicity, mutagenicity, carcinogenicity, or special studies pertinent to the aforementioned product and contaminants if no MCL is available. Please include the report title, report date, and author or conducting laboratory (if any).

_____

_____

_____

_____

I hereby state that all information above is accurate and complete to the best of my knowledge.

_____ _____

Signature Date

APPENDIX E – CTL PROTOCOL FOR ANSI/NSF 61

MORTAR CUBE FABRICATION

CONSTRUCTION TECHNOLOGY LABORATORIES, INC.

Document Control Cover Sheet

Title **Fabrication of Mortar Cubes for ANSI/NSF 61 Testing**

Author	**H. M. Kanare**
Document Type	**Laboratory Procedure**
Document No.	**001 Version 3**
Date Issued	**29 June 1995**
Replaces	**Version 1 issued 27 July 1994**
Originally issued	**27 July 1994**
Approved	**H. M. Kanare**

1.0 SCOPE

1.1 This procedure covers fabrication of portland cement mortar specimens for conditioning and exposure to water according to ANSI/NSF 61 procedures. The collected water will be tested for selected organic and inorganic compounds, metals, and radionuclides for conformance with ANSI/NSF 61 Appendix A criteria. Cement that meets these criteria based on these tests is acceptable for use as a constituent in portland cement–based products for drinking water system components, such as, but not limited to, mortar linings for pipe, concrete pipe, and concrete water retention structures.

1.2 Because tests for contaminants in drinking water extracts must be performed at extremely low levels, every effort must be made to avoid extraneous sources of contaminants throughout the sampling, specimen preparation, and handling processes.

2.0 REFERENCES

[Unless indicated otherwise, all references are to the latest published versions of standards.]

ASTM C 183, "Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement," Vol. 4.01, American Society for Testing and Materials, Philadelphia.

ASTM C 109, "Standard Test Method for Compressive Strength of Hydraulic Cement Mortars," Vol. 4.01, American Society for Testing and Materials, Philadelphia.

ASTM D 1193, "Standard Specification for Reagent Water," Vol. 11.01, American Society for Testing and Materials, Philadelphia.

ASTM C 511, "Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes," Vol. 4.01, American Society for Testing and Materials, Philadelphia.

3.0 APPARATUS

3.1 Sample Collection equipment required to obtain samples as described in ASTM C 183, including slotted sampling tubes, pans, riffle splitters, and scoops.

3.2 Containers for preserving, transporting, and storing cement samples, including screw-top glass jars with Teflon®-lined lids.

3.3 Mortar cube preparation equipment conforming to ASTM C 109 except that molds shall be 2-in or 50-mm virgin polypropylene or polyethylene plastic forms, not recycled, containing no detectable metals. (Available, for example, from American Cube Mold, 9241 Ravenna Road, Twinsburg, OH, phone 216-467-1688.)

3.4 Moist curing room or cabinet conforming to ASTM C 511; Polyethylene beakers or straight-sided cylindrical containers with bottom drainage holes for curing specimens; Glass or polyethylene watch glasses large enough to cover the containers and polyethylene Rebel hooks to support the watch glasses above the containers.

4.0 REAGENTS

4.1 Water must meet ASTM D 1193 Type II requirements.

4.2 Graded Ottawa sand conforming to ASTM C 778 requirements must be washed as described in Section 6.0 below and oven dried before use.

5.0 CEMENT SAMPLE COLLECTION, PRESERVATION, HANDLING, AND STORAGE

5.1 Obtain samples of cement weighing at least 10 kg in accordance with the applicable sections of ASTM C 183, "Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement." Sampling tools such as slotted sampling tubes, pans, riffle splitters, and scoops must be scrupulously clean and wiped with isopropyl alcohol before use to minimize contamination.

5.2 Pack the samples in moisture-proof, airtight containers, clearly labelled with the source and date of sampling. Glass containers with Teflon®-lined screw-top lids are preferred to avoid contamination with trace organics and metals sometimes found in plastic containers. Glass containers shall be cleaned before filling by washing with soap and water, rinsing repeatedly with deionized water (ASTM D 1193 Type II), final rinsing with methanol or isopropyl alcohol, and baking at 300° C to remove organic compounds. Teflon®-lined lids must be washed, rinsed, and dried at 105° C, since higher temperatures will deform the lids.

5.3 To minimize the possibility of contamination, samples shall not be filled near a running motor or any type of exhaust system. Containers should be filled as much as possible to eliminate head space above the sample.

6.0 WASHING SAND

6.1 Graded Ottawa sand must be washed before use. Obtain an unopened 50-lb sack of sand and place approximately one-half of the sand into a clean 5-gal polyethylene bucket. Run tap water into the bucket to cover the sand. Wearing a clean rubber glove, reach into the sand and turn over handfuls of sand for approximately one minute, permitting the water to remove contaminants. Decant as much water as possible and repeat washing with tap water four more times. The last decantation should run clear. If not, continue washing until the tap water runs clear. Wash five times with ASTM D 1193 Type II deionized water in the same manner. Decant the last rinse water and transfer the damp sand onto clean, metal drying trays. Place the trays in a forced-air convection oven at 105°C for a least 2 hours or until the sand is dry and free-flowing. Place the sand into a clean, dry, 5-gal polyethylene bucket, cover and label.

7.0 MORTAR CUBE SPECIMEN FABRICATION

7.1 The number of mortar cube specimens to be fabricated will depend on the volume of extraction water required for the various analyses which in turn is determined by the specific analytes and their required detection limits. The certification organization will instruct the specimen fabrication technician how many cubes to make.

7.2 Make mortar cube specimens for each cement to be tested in accordance with the relevant sections in the most recent version of ASTM C 109, "Standard Test Method for Compressive Strength of Hydraulic Cement Mortars," with the following exceptions:

7.2.1 Mix water shall meet ASTM D 1193 Type II requirements. Mixing bowls, paddles, molds, tamping rods, trowels, and any other items in contact with the cement, sand, water, or mortar shall be washed with soap and water, copiously rinsed with tap water, given a final rinse with Type II water followed by a rinse with isopropyl alcohol, and dried before use. Between multiple batches of the same cement, rinse tools with tap water followed by Type II deionized water and wipe dry with a lint-free cotton towel. Before

use, the mixer must be cleaned thoroughly to remove grease, dirt, and any other materials that might fall into and contaminate the mortar.

7.2.2 Mortar specimens shall be cast in 2-in or 50-mm virgin polypropylene or polyethylene plastic cube molds, not recycled, containing no detectable metals. No mold release agent shall be used. Before use, plastic molds shall be washed with 10% hydrochloric acid and rinsed as described in Section 7.2.1 above.

7.2.3 The tamping rod shall meet the dimensions specified in ASTM C 109 but shall be made of ultrahigh molecular weight polyethylene.

7.3 Remove the specimens from the molds after 24 hr±1 hr, place specimens in polyethylene beakers or straight-sided cylindrical containers and cover with an inverted glass or plastic watch glass supported on polyethylene Rebel hooks. (See Figure 1.) This arrangement permits circulation of moist air without ponding or leaching of the specimen during the curing period. Place the specimen containers in a moist cabinet conforming with ASTM C 511 and cure until the specimen has reached an age of 28 days ±12 hr.

7.4 After curing, remove the specimens from the moist cabinet and air dry at 23±2°C/50±5% relative humidity for 7 days. Protect the specimens from contamination during air drying. Identify the specimens during air drying by placing labeled tags on the racks immediately adjacent to specimens. Do not write on the specimens with a pen, pencil, engraving tool, or marker of any kind. After drying, place specimens in polyethylene bags, wrap with aluminum foil, and label the outside of the aluminum foil with a felt-tipped marker. This procedure minimizes possible contamination from labelling. If specimens will be shipped to another facility for testing, pack securely to avoid chipping or breakage. Specimens that are chipped, cracked, or otherwise physically damaged must be discarded and cannot be used for further tests.

7.5 At the time of mortar cube specimen preparation, preserve the following quantities of the cement, sand, and water used, in case additional testing will be necessary:

cement	1 kg
graded Ottawa sand	1 kg
water	2 L

Glass containers with Teflon®-lined screw top lids, washed as described above, are preferred for storing the cement and sand. Water shall be stored in a polyethylene or polypropylene screw top jar. Containers shall be washed, rinsed, and dried as described in Section 6.3 above.

8.0 CHANGES TO THIS PROCEDURE

7.1 The specimen fabrication technician shall immediately notify the project manager if any part of this procedure cannot be performed as described in this document.

7.2 Planned changes to this procedure may be made only with the authorization of the project manager who must document in writing the reason for such changes. For example, a client may request that specimens be fabricated with a special aggregate or with admixtures.

9.0 REPORTING

8.1 The specimen fabrication technician shall report to the project manager that the specimens were fabricated in accordance with this procedure or any changes not in accordance with this procedure.

8.2 The project manager shall prepare a written report for the client indicating that the specimens were fabricated in accordance with this procedure or any changes not in accordance with this procedure. The report shall include the client's name, sample identification, date and time the mortar cubes were fabricated. The report shall be signed and dated by the fabrication technician and the project manager. The project manager shall complete the Fabrication Record Sheet as shown on the following page.

CTL *Structural/Architectural Engineering, Consulting, & Materials Technology*

5420 Old Orchard Road, Skokie, Illinois 60077-1030
708/965-7500 **800/522-2CTL** Fax: 708/ 965-6541

MORTAR CUBES FOR ANSI/NSF 61
FABRICATION RECORD SHEET

Client: _____ CTL Project No.:_____

Project: _____ CTL Proj. Mgr.: _____

Contact: _____ Date: _____

Submitter: _____

Sample Identification

CTL ID _____ Client's ID_____

Number of cube specimens to fabricate _____

Preparation

Equipment prepared and cleaned by _____ date _____

Sand washed by _____ date _____

Batch water purity _____MΩ-cm; temperature _____°F at _____ am/pm (*circle one*)

Mixing Room Environmental Conditions

Room No. _____

start _____°F / _____ RH at _____ am/pm (*circle one*)

finish _____°F / _____ RH at _____ am/pm (*circle one*)

Notes

_____

_____

_____

_____

Cubes fabricated by _____ Approved _____

sign *date* *sign* *date*

CTL *Structural/Architectural Engineering, Consulting, & Materials Technology*

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708/965-7500 **800/522-2CTL** Fax: 708/ 965-6541

MORTAR CUBES FOR ANSI/NSF 61
CURING/DRYING RECORD SHEET

Client: _____ CTL Project No.:_____

Project: _____ CTL Proj. Mgr.: _____

Contact: _____ Date: _____

Submitter: _____

Sample Identification

CTL ID _____ Client's ID_____

Cube specimens fabricated on _____ (date) Number of cube specimens _____

Curing Room Environmental Conditions

Room No. _____

start _____°F / _____ RH at _____ am/pm (*circle one*) on _____ (date) by _____

finish _____°F / _____ RH at _____ am/pm (*circle one*) on _____ (date) by _____

Drying Room Environmental Conditions

Room No. _____

start _____°F / _____ RH at _____ am/pm (*circle one*) on _____ (date) by _____

finish _____°F / _____ RH at _____ am/pm (*circle one*) on _____ (date) by _____

Notes

_____

_____

_____

Curing set up by _____ Drying set up by _____

sign *date* *sign* *date*

Approved _____

sign *date*

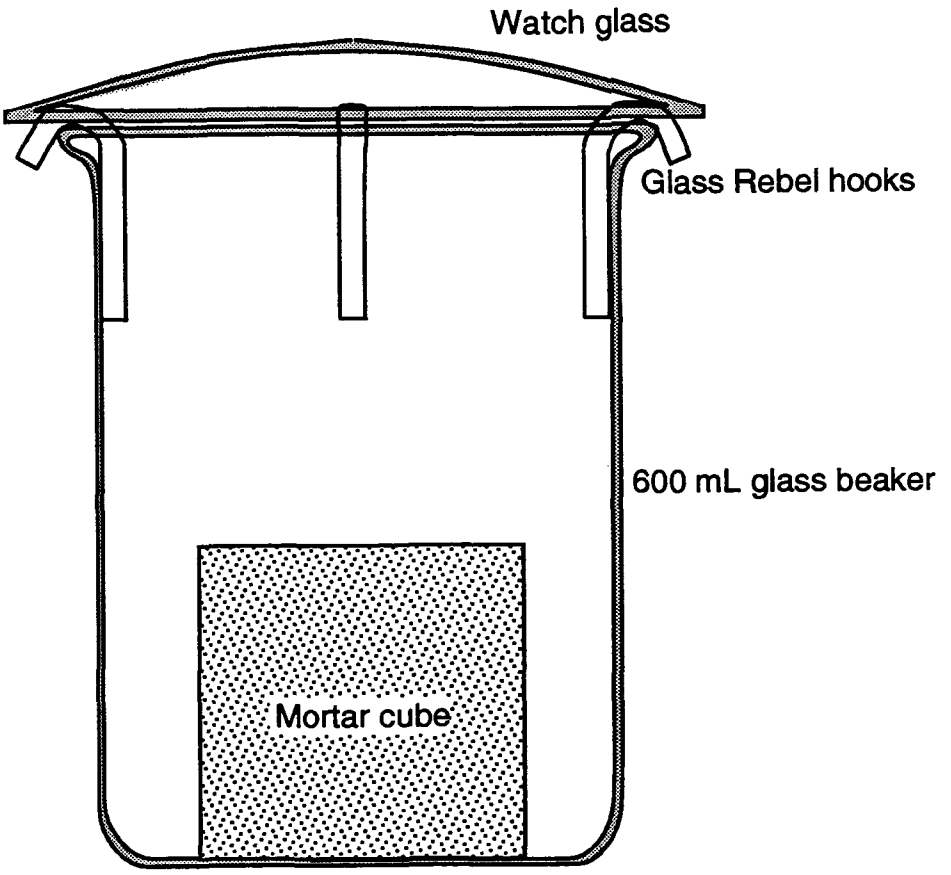


Figure 1. Arrangement for moist curing mortar cubes. The whole apparatus is placed in a moist cabinet. Inverted watch glass supported above the beaker permits moist air circulation without bringing liquid water into contact with the specimen.

APPENDIX F – CTL/PCA BENCHWORK

COMPARING EXTRACTION PROTOCOLS

Comparison of ANSI/NSF 61 Extraction Procedures

PCA Project 91-06
CTL Project H40013

Principal Investigator: H. M. Kanare

Purpose

This test program was performed to determine whether mortar cubes subjected to two drinking water extraction procedures in ANSI/NSF 61 Appendix B produce similar or significantly different results. The differences between the two protocols are shown in the following table:

Method	Conditioning	Extraction	Results
Pipes and Related Products ANSI/NSF 61 Appendix B Section 3	50 mg/L chlorine disinfection soak 24 hr, then condition 14 days, 23°C, pH 8	16 hr, 30°C pH 5 or 10 for metals, pH 8 for organics	normalized for surface area-to-volume ratios
Barrier Materials ANSI/NSF 61 Appendix B Section 4	200 mg/L chlorine disinfection spray then condition 2 days, 23°C pH 5 or 10	72 hr, 23°C pH 5 or 10 for metals, pH 8 for organics	normalized to 24 hr and then for surface area-to-volume ratios

Experimental

Cement Selection – A commercially-available portland cement meeting ASTM C 150 Type II requirements was chosen for this study. Oxide analysis, calculated compounds, and trace metal concentrations in this cement are shown in Tables F-1 and F-2. Clinker for this cement was produced at a dry process plant using a four component raw mix of geological materials:

Limestone: Finely microcrystalline calcite to coarse-grained calcitic marble containing traces of quartz, limonite (iron oxyhydroxide), and albite (sodium plagioclase feldspar).

Shale: Quartz-muscovite schist with abundant plagioclase and possibly sericite. Calcite as described above in sample dust and in some schist particles.

Silica: Metaquartzite with minor amounts of mica and plagioclase feldspar and ferromagnesium minerals.

Iron: Largely limonite with included quartz, plagioclase, calcite, mica, and other constituents.

The kiln was fired with 63% petroleum coke (0.5-1% ash) and 37% waste solvents (such as waste oils, chlorinated solvents, paint thinners; 2-4% ash) introduced at the burner pipe. This particular cement was chosen for three reasons: 1) clinker was burned with waste solvents; 2) this plant recycled approximately 50% kiln dust; and 3) the cement contained chemical elements of environmental interest in concentrations generally equal to, or higher than, mean concentrations of these elements in North American cements (Figure F-1). For these reasons, this cement provided a reasonable basis to look for organic compounds, radionuclides, and environmentally important metal elements in the extraction waters.

The fact that precast concrete producers might use an ASTM Type III cement for concrete pipe, mortar linings, or tanks was considered. Many cement plants produce a single clinker that can be used to make cement meeting Type I strength requirements while also meeting Type II chemical requirements. Such a product is commonly referred to as Type I/II cement. If the clinker is more finely ground, the cement might meet Type III early strength requirements. Thus, one suite of raw materials is often sufficient at a cement plant to produce the type of cement that might be used for general construction and for drinking water system components.

Mortar Cube Fabrication – Sand for mortar cubes was graded sand (U. S. Silica, Ottawa IL) meeting ASTM C 778 requirements. The sand was rinsed by hand-agitating with five changes of tap water followed by five changes of deionized water (>1MΩ-cm resistivity), drained, and dried overnight on fiberglass trays at 105°C in a forced-air oven. The sand was stored in a covered polyethylene bucket until needed.

Water for mortar cubes was deionized to 18.3 MΩ-cm resistivity (Barnstead ultrapure PCS) and passed through a 0.2 μm final filter. Water was drawn through the deionizer and allowed to equilibrate to room temperature overnight in a 20-L HDPE carboy.

Two-inch (51 mm)cube molds were new polypropylene (American Cube Mold, Twinsburg OH). The molds were washed by hand in hot soapy water (Micro), rinsed five times with tap water, dipped in 10% hydrochloric acid (Baker, ACS Reagent), rinsed five time with tap water, rinsed five times with deionized water (>1MΩ-cm resistivity), and air dried overnight. The clean molds were stored in HDPE plastic bags until needed.

All items that contacted the cement, sand, or mortar such as scoops, spatulas, mixing bowl, paddle, trowels, and tamping rod were similarly cleaned and stored until needed,

Seventy-two mortar cubes (eight batches of nine cubes) were fabricated on one day in accordance with ASTM C 109 with the following exceptions: No mold release agent (form oil) was used; The tamping rod was made from ultrahigh molecular weight polyethylene instead of rubber. Specimens were cast in polypropylene molds and covered with polyethylene sheets for the first 24 hr of moist curing. The molds were then split open with a utility knife, the cubes were removed and placed into 4-L HDPE buckets fitted with polyethylene clips to hold inverted watch glasses (Figure F-2). This arrangement permitted moist air to circulate around the cubes but kept liquid water from accumulating in the bottom of the buckets. Cubes from different batches made throughout the day were distributed into different buckets for curing to randomize bias that might have been introduced in mixing, placing, or curing.

The cubes were cured in a moist room meeting ASTM C 511 for 28 days then placed on plastic racks in a room at 23±2°C, 50±5% relative humidity to air dry for seven days.

Extractions – One-liter wide-mouth glass jars with teflon-lined lids (I-Chem) for use as extraction vessels were cleaned before use: washed by hand in hot soapy water (Micro), rinsed five times with tap water, rinsed with 10% hydrochloric acid (Baker, ACS Reagent), rinsed five times with tap water, rinsed five times with deionized water (>1MΩ-cm resistivity), filled with 18.3 MΩ-cm deionized water with no headspace and covered until needed.

All of the 72 mortar cubes were rinsed with tap water followed by deionized water (ASTM D 1193 Type II) to remove extraneous surface matter. The cubes were split into two batches of 36 cubes each: Set A followed the pipe protocol and Set B followed the barrier materials protocol. Three mortar cubes were placed in each one liter jar, giving a cube surface-area-to water-volume ratio of 464 cm^2 per 550 mL (measured) in the nominally one liter jars. Blanks were carried throughout for each treatment.

Set A cubes were conditioned 14 days at 23±5°C in pH 8 extraction water containing 25 mL 0.04M $CaCl_2$ (for hardness) and 25 mL 0.04M $NaHCO_3$ (pH adjuster) per liter of extraction water. The water was changed every 24 hr. To simulate disinfection, the first exposure contained 50 mg/L available chlorine diluted from 5% NaOCl stock solution, except water for organic analysis which had no added chlorine. Subsequent exposures contained 2 mg/L available chlorine, except water for organic analysis which had no added chlorine. (Stock solutions for hardness, pH, and chlorine were prepared according to ANSI/NSF 61 Section 12.) Following the 14 days conditioning, the cubes were exposed in pH 5 and 10 waters for metals and pH 8 water (without added chlorine) for organics. Exposure without agitation for 16 hr at 30°C was achieved by placing the filled jars into an environmental chamber previously prepared at 30°C. The exposure waters were decanted into collection jars prepared according to Standard 61 Appendix B Section 8.

Set B cubes were disinfected with 200 mg/L available chlorine disinfection spray (except cubes for organic analysis) and allowed to rest 30 min, then rinsed with tap water followed by deionized water (ASTM D 1193 Type II). Cubes were conditioned two days at 23±5°C in pH 5 or 10 water for metals and pH 8 water for organics as described above. The water was changed every 24 hr. Following the two days conditioning, the cubes were exposed without agitation in pH 5, 8, and 10 waters at 23±2°C for 72 hr. The exposure waters were collected as described above.

Analysis

Extraction waters were analyzed at CTL for trace metals using methods listed in Standard 61 Appendix B Section 10.3. Aliquots were delivered to three subcontract laboratories for other analyses. The methods are identified in the attached reports.

Subcontractor	**Analyses**
Daily Analytical Laboratories Peoria, IL (State of Illinois certified for drinking water analysis.)	volatile organics
Teledyne Brown Engineering Northbrook, IL (State of Illinois certified for drinking water analysis.)	radionuclides
Triangle Laboratories of RTP Durham, NC	2,3,7,8-TCDD dioxin

Results

Results of analyses are shown in the attached reports. Most results (before normalization) were below detection limits. The following table shows results in mg/L in the extraction waters (not normalized) for inorganic analytes determined above detection limits. Sets A and B had identical ratios of mortar cube surface area to water volume.

	Set A – Pipe Protocol (16 hr extraction)		Set B – Barrier Material Protocol (72 hr extr'n)		Mean blank
Analyte	**pH 5**	**pH 10**	**pH 5**	**pH 10**	**pH 5 & 10**
Arsenic (As)	0.004	0.005	0.002	0.004	<0.002
Barium (Ba)	0.005	0.004	<0.002	<0.003	<0.002
Chromium (Cr)	0.004	0.006	0.004	0.030	<0.0002
Copper (Cu)	0.002	0.002	0.002	0.001	0.003
Aluminum (Al)	0.068	0.733	0.18	1.4	0.010
Radionuclides (pCi/L)					
gross alpha	<0.4	<0.9	2.0	5.7	<0.8
gross beta	11.9	13.1	95.1	81.5	<0.6

The following table compares results normalized to six-inch pipe; Set B was also normalized to 24 hr while Set A results are shown for the 16 hr extraction, in conformance with NSF toxicologists standard data treatment of extraction concentrations.

	Set A – Pipe Protocol 16 hr extraction, normalized to 6-in pipe		Set B – Barrier Material Protocol normalized to 24 hr, 6-in pipe		Maximum allowable level (10% of NPDWS)
Metals (mg/L)	**pH 5**	**pH 10**	**pH 5**	**pH 10**	
Arsenic (As)	0.001	0.002	0.0002	0.0004	0.0006
Barium (Ba)	0.002	0.001	<0.0002	<0.0003	0.2
Chromium (Cr)	0.001	0.002	0.0004	0.0030	0.01
Copper (Cu)	0.0006	0.0006	0.0002	0.0001	0.13
Aluminum (Al)	0.021	0.229	0.019	0.15	0.005 – 0.02
Radionuclides (pCi/L)					
gross alpha	<0.12	<0.28	0.21	0.59	1.5 pCi/L
gross beta	3.7	4.1	9.9	8.5	5.0 pCi/L (4 mrem/y)

Discussion

Metals — Antimony, beryllium, cadmium, lead, mercury, nickel, selenium, thallium, and zinc were all below detection limits (less than one-tenth the EPA MCLs) before normalization. Barium and copper were detected in the extraction waters (before normalization) well below their respective MALs. Arsenic from Sets A and B in pH 5 and 10 extracts was detected in the extraction water (before normalization) but very close to the detection limit. (The arsenic detection limit was 0.002 mg/L (2 ppb) and quantification limit was 0.0033 mg/

L (3.3 ppb)). Normalized arsenic results for Set B indicate this cement would be acceptable for use in a pipe with six inch (or larger) inner diameter while the Set A results indicate the cement would be acceptable in a pipe of 7.5-inch or larger diameter. Chromium was detected in the extraction waters. Chromium results normalized for six inch pipe from both Sets A and B are well below the Maximum Allowable Level. Aluminum appears to be greater than one-tenth the EPA Secondary MCL in pH 5 and 10 extracts according to both protocols. Aluminum has an SMCL because it can cause turbidity in drinking water; it does not present a health risk at these levels (56 FR 3573; see also *Drinking Water and Health*, National Research Council Safe Drinking Water Committee, pp. 106, 205–211, 1977.)

Radionuclides — The analyses for gross alpha and gross beta emitters are screening tests used to determine if specific radionuclides are present that present potential health risks. Concentrations of gross beta normalized for six-inch pipe from Set B, pH 5 and pH 10, are greater than the 5.0 pCi/L limit. To provide additional water to determine the specific radionuclides contributing to the beta emissions, additional mortar cubes were soaked in pH 5 extraction water for seven days. This extended soaking time was chosen to provide sufficient concentrations of possible contaminants well above detection limits for the speciation tests performed by gamma isotope emission analysis. Results indicated only potassium-40 was detected. Because U.S. adults ingest 2,300 pCi ^{40}K per day, mostly from foodstuffs (*Drinking Water and Health*, National Research Council Safe Drinking Water Committee, p. 859, 1977.), the amount coming from drinking water is negligible by comparison.

Dioxin — 2,3,7,8-TCDD was not detected in Set A or B using the single pH 8 extraction water required by Standard 61. Reporting limits were:

	Set A – Pipe Protocol (16 hr extraction)		**Set B – Barrier Material Protocol (72 hr extr'n)**	
	pH 8	**blank**	**pH 8**	**blank**
Analyte				
2,3,7,8-TCDD	<1.5 pg/L	<1.8 pg/L	<1.6 pg/L	<1.1 pg/L

Volatile Organics — Organic compounds regulated under the National Primary Drinking Water were tested for. Results are shown in the attached report from Daily Analytical Laboratories. None of the regulated compounds were detected. Detection limits were one-tenth of the NPDWS or lower.

Comparison of Protocols — Since nearly all analytes (metals, volatile organics, dioxin, radionuclides) were below detection limits in all extraction waters, we are left with very few results to look for differences between the test methods. Of the few elements detected, chromium and aluminum appear significantly more soluble in the pH 10 extraction waters than in the pH 5 extraction waters. Dissolution rates appear to be non-linear since normalization of both protocols to 24 hr does not produce the same results. For example:

	Set A – Pipe Protocol normalized to 24 hr, 6-in pipe		**Set B – Barrier Material Protocol normalized to 24 hr, 6-in pipe**	
	pH 5	**pH 10**	**pH 5**	**pH 10**
Aluminum, mg/L	0.032	0.34	0.019	0.15
Gross beta, pCi/L	5.6	6.1	9.9	8.5

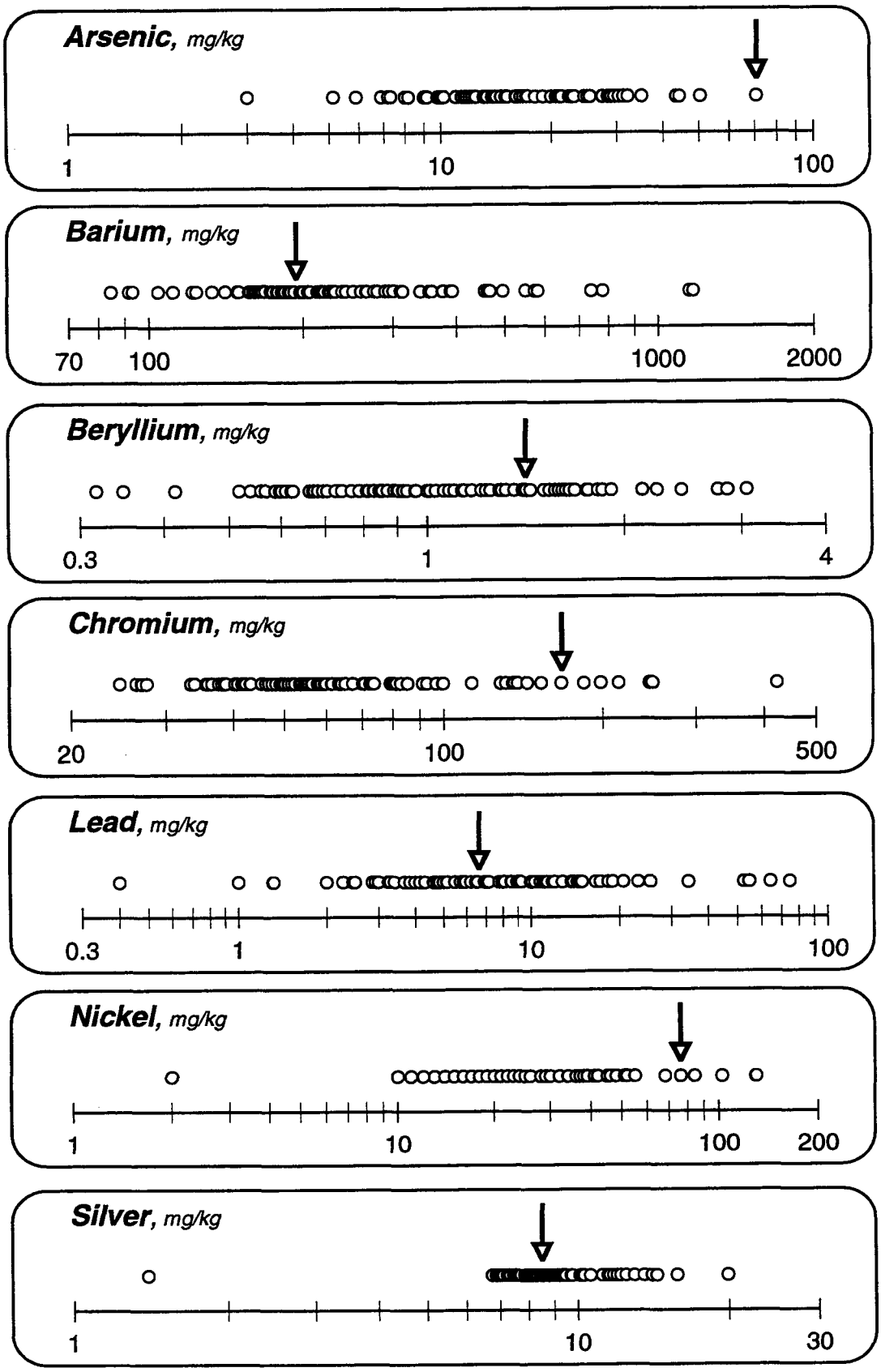
For the cement tested, the barrier material protocol appears to be a more stringent test for radionuclides while the pipe protocol appears to be a more stringent test for aluminum. This is a tentative conclusion based on very few results from only one cement. However, the overall results are consistent with those reported by other organizations: Portland cements tested to date according to protocols in ANSI/NSF 61 are acceptable for use in drinking water system components.

Acknowledgments

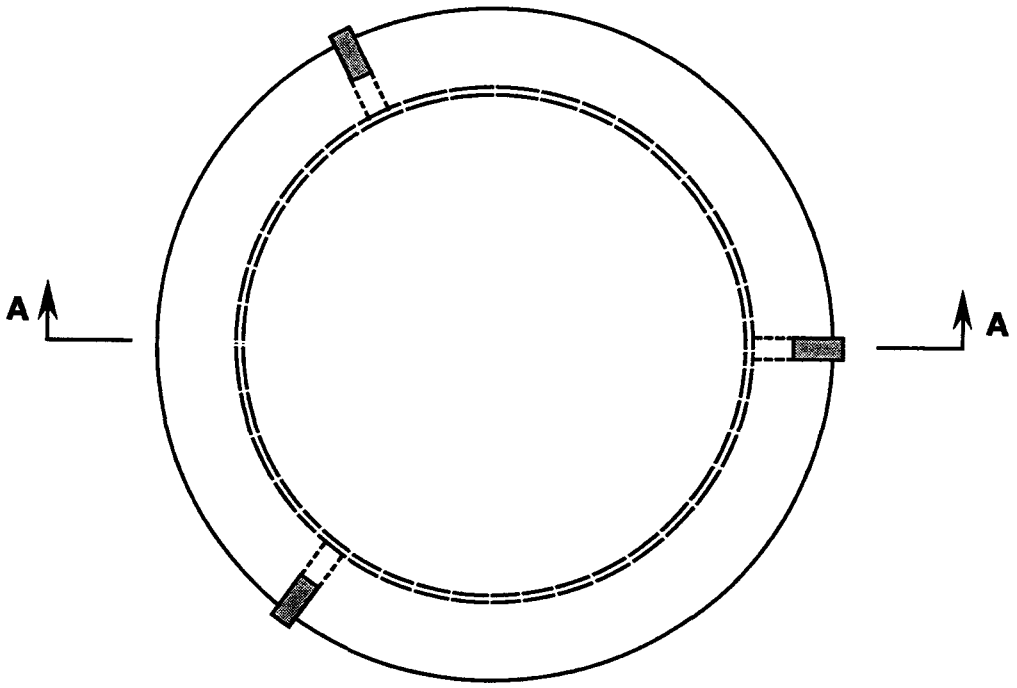
The author acknowledges the capable assistance of CTL staff who performed the laboratory work: Peter Marlo fabricated the mortar cubes to the exacting standard; Nevin Bouschlicher performed the tedious water preparation, conditioning, and extractions; JoAnne Delles and Sebastian Padiyara performed the trace metal analyses at previously unexplored low detection limits. The usefulness of the results is due to all of their careful attention to details.

The research reported in this paper (PCA R&D Serial No. 2041a) was conducted at Construction Technology Laboratories, Inc. with the sponsorship of the Portland Cement Association (PCA Project Index No. 91-06). The contents of this paper reflect the views of the author, who is responsible for the facts and accuracy of the data presented. The contents do not necessarily reflect the views of the Portland Cement Association.

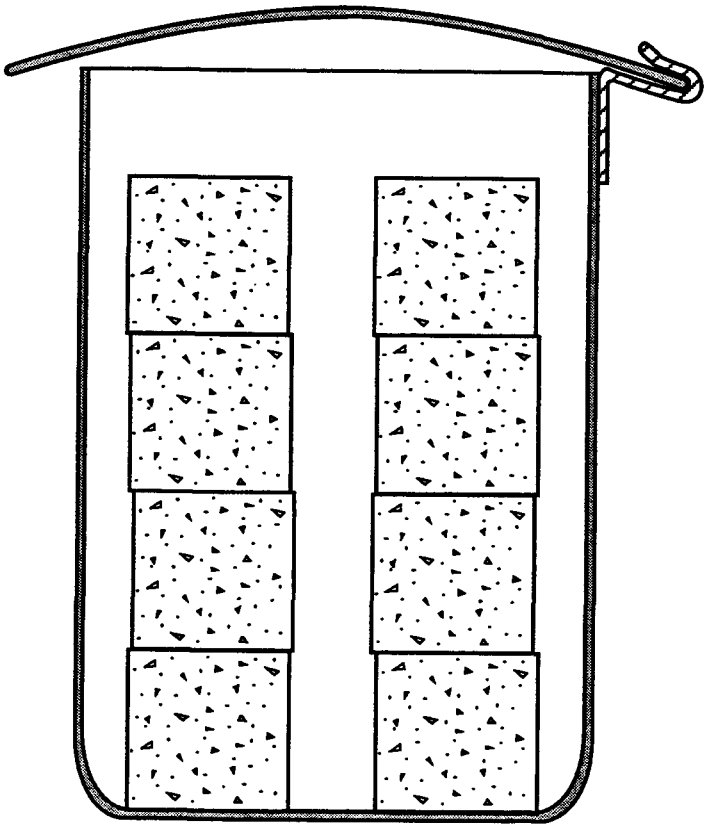
Figure F-1. Trace Elements in Cement Used to Make Mortar Cubes Compared to 95 North American Cements



Arrows indicate concentrations of trace elements in cement selected to make mortar cubes for this study. Open circles indicate concentrations in 95 North American cements with non-detect results shown as if present at the detection limits. Elements not shown (Sb, Cd, Hg, Se, Tl) were below detection limits in the selected cement.



TOP VIEW



SECTION A-A

Figure F-2. Arrangement for moist curing mortar cubes to avoid liquid water intrusion.

TABLE F-1

CTL Structural/Architectural Engineering, Consulting, & Materials Technology

5420 Old Orchard Road, Skokie, Illinois 60077-1030
708/965-7500 800/522-2CTL Fax: 708/965-6541

Client:	Portland Cement Association	CTL Project No.:	H40014
Project:	Drinking Water Issues	CTL Proj. Mgr.:	Howard Kanare
Contact:	A. E. Fiorato	Analyst:	Don Broton
Submitter:	Howard Kanare	Approved:	
Sample rec'd:	27-Feb-95	Date Analyzed:	02-Mar-95
		Date Reported:	3-Mar-95

REPORT OF CHEMICAL ANALYSIS

Client's Sample ID: Cement used for NSF 61 mortar cubes
Material type: Cement

Analyte	Weight %
SiO_2	20.43
Al_2O_3	4.70
Fe_2O_3	3.02
CaO	63.34
MgO	2.78
SO_3	2.60
Na_2O	0.18
K_2O	0.52
TiO_2	0.23
P_2O_5	0.06
Mn_2O_3	0.07
SrO	0.15
L.O.I. (950°C)	1.51
Total	99.60
Alkalies as Na_2O	0.52
Insoluble Residue	
Free CaO	

Calculated Compounds per ASTM C 150-92

C3S	57
C2S	15
C3A	8
C4AF	9
ss(C4AF + C2F)	---

Notes:
1. This analysis represents specifically the sample submitted.
2. Oxide analysis by X-ray fluorescence spectrometry. Samples fused at 1000°C with $Li_2B_4O_7$.
3. Values for TiO_2 and P_2O_5 are added to the Al_2O_3 when the compounds are calculated, in accordance with ASTM C 150.
4. X-Ray Fluorescence oxide analysis meets the precision and accuracy requirements for rapid methods per ASTM C 114-88. Most recent re-qualification date is August 22, 1993.

Table F-2. Trace elements in cement used to make ANSI/NSF61 mortar cubes

Analyte	Concentration in cement (mg/kg)
Antimony (Sb)	<0.19
Arsenic (As)	70.6
Barium (Ba)	197
Beryllium (Be)	1.51
Cadmium (Cd)	<0.13
Chromium (Cr)	167
Lead (Pb)	6.45
Mercury (Hg)	0.0255
Nickel (Ni)	76
Selenium (Se)	<4
Silver (Ag)	8.03
Thallium (Tl)	<0.6

Notes:

1. EPA procedure 3050 used for total metals digestion, except Sb (3005) and Hg (7471).

Table F-3. Results of trace metals analyses in extraction waters (not normalized).

Sample ID:	Set A pH 5	Set A pH 10	Set B pH 5	Set B pH 10	mean blank
Analyte	mg/L	mg/L	mg/L	mg/L	mg/L
Antimony (Sb)	0.003	<0.0031	0.0032	<0.0031	<0.0031
Arsenic (As)	0.0039	0.0051	0.0015	0.004	<0.002
Barium (Ba)	0.005	0.0044	<0.0017	<0.0028	<0.002
Beryllium (Be)	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
Cadmium (Cd)	0.000087	<0.000051	<0.000051	<0.000051	<0.00005
Chromium (Cr)	0.0042	0.0064	0.0044	0.0304	<0.0002
Copper (Cu)	0.0021	0.0024	0.0019	0.0014	0.003
Lead (Pb)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mercury (Hg)	<0.00017	<0.00017	<0.00017	<0.00017	<0.0002
Nickel (Ni)	<0.0019	<0.0011	0.0011	<0.0011	<0.001
Selenium (Se)	<0.0023	<0.0023	<0.0023	<0.0023	<0.002
Thallium (Tl)	<0.00053	<0.00053	<0.00053	<0.00053	<0.005
Aluminum (Al)	0.068	0.733	0.18	1.4	0.01
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005	<0.005

DA Daily Analytical Laboratories
1621 W. Candletree Drive Peoria, Illinois 61614
Tel. (309) 692-5252 (800) 752-6651

CTL
5420 Old Orchard Road
Skokie, IL 60077-1030

Attn: Mr. Howard Kanare

Work ID: Proj.#H40013 & ~~#404098~~
P O # : ~~14114B~~

Date Received: 07/15/94
Date of Report: 07/26/94
Work Order: 94-07-650
Job Number:
# of Samples: 7

Certified By: Patricia Schultz-Benker
Patricia Schultz-Benker
Senior Organic Chemist

IEPA Registry No. 100219

Daily Analytical is an IEPA certified laboratory.
All analyses are performed by methodology
acceptable to USEPA and IEPA.

Daily Analytical Laboratories
1621 W. Candletree Drive Peoria, Illinois 61614
Tel. (309) 692-5252 (800) 752-6651

Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-A FRACTION 01A Date & Time Collected not specified

VOLATILE ORGANICS ANALYSIS
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
Benzene	nd	<0.5	ug/l
Carbon Tetrachloride	nd	<0.5	ug/l
1,2-Dichloroethane	nd	<0.5	ug/l
Trichloroethene	nd	<0.5	ug/l
1,4-Dichlorobenzene	nd	<0.5	ug/l
1,1-Dichloroethene	nd	<0.5	ug/l
1,1,1 Trichloroethane	nd	<0.5	ug/l
Vinyl Chloride	nd	<0.5	ug/l
1,2-Dichlorobenzene	nd	<0.5	ug/l
cis-1,2-Dichloroethene	nd	<0.5	ug/l
trans-1,2-Dichloroethene	nd	<0.5	ug/l
1,2-Dichloropropane	nd	<0.5	ug/l
Ethylbenzene	nd	<0.5	ug/l
Chlorobenzene	nd	<0.5	ug/l
Styrene	nd	<0.5	ug/l
Tetrachloroethene	nd	<0.5	ug/l
Toluene	nd	<0.5	ug/l
m,p-Xylenes	nd	<0.5	ug/l
o-Xylene	nd	<0.5	ug/l
Dichloromethane	nd	<0.5	ug/l
1,1,2-Trichloroethane	nd	<0.5	ug/l
1,2,4-Trichlorobenzene	nd	<0.5	ug/l
Chloroform	nd	<0.5	ug/l
Bromodichloromethane	nd	<0.5	ug/l
Chlorodibromomethane	nd	<0.5	ug/l
Bromoform	nd	<0.5	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

Daily Analytical Laboratories
1621 W. Candletree Drive Peoria, Illinois 61614
Tel. (309) 692-5252 (800) 752-6651

Page 3 DAILY LABS REPORT Work Order # 94-07-650
Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-A FRACTION 01A Date & Time Collected not specified

VOLATILE ORGANICS ANALYSIS (cont.)
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
1,3-Dichlorobenzene	nd	<1.0	ug/l
Dibromomethane	nd	<1.0	ug/l
1,1-Dichloropropene	nd	<1.0	ug/l
1,1-Dichloroethane	nd	<1.0	ug/l
1,1,2,2-Tetrachloroethane	nd	<1.0	ug/l
1,3-Dichloropropane	nd	<1.0	ug/l
Chloromethane	nd	<1.0	ug/l
Bromomethane	nd	<1.0	ug/l
1,2,3-Trichloropropane	nd	<1.0	ug/l
1,1,1,2-Tetrachloroethane	nd	<1.0	ug/l
Chloroethane	nd	<1.0	ug/l
2,2-Dichloropropane	nd	<1.0	ug/l
2-Chlorotoluene	nd	<1.0	ug/l
4-Chlorotoluene	nd	<1.0	ug/l
Bromobenzene	nd	<1.0	ug/l
cis-1,3-Dichloropropene	nd	<1.0	ug/l
trans-1,3-Dichloropropene	nd	<1.0	ug/l
Ethylene Dibromide (EDB)	nd	<1.0	ug/l
1,2-Dibromo-3-Chloropropane	nd	<1.0	ug/l
1,2,4-Trimethylbenzene	nd	<1.0	ug/l
1,2,3-Trichlorobenzene	nd	<1.0	ug/l
n-Propylbenzene	nd	<1.0	ug/l
n-Butylbenzene	nd	<1.0	ug/l
Naphthalene	nd	<1.0	ug/l
Hexachlorobutadiene	nd	<1.0	ug/l
1,3,5-Trimethylbenzene	nd	<1.0	ug/l
4-Isopropyltoluene	nd	<1.0	ug/l
iso-Propylbenzene	nd	<1.0	ug/l
tert-Butylbenzene	nd	<1.0	ug/l
sec-Butylbenzene	nd	<1.0	ug/l
Trichlorofluoromethane	nd	<1.0	ug/l
Dichlorodifluoromethane	nd	<1.0	ug/l
Bromochloromethane	nd	<1.0	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

Daily Analytical Laboratories
1621 W. Candletree Drive Peoria, Illinois 61614
Tel. (309) 692-5252 (800) 752-6651

Page 4 DAILY LABS REPORT Work Order # 94-07-650
Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-B FRACTION 02A Date & Time Collected not specified

VOLATILE ORGANICS ANALYSIS
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
Benzene	nd	<0.5	ug/l
Carbon Tetrachloride	nd	<0.5	ug/l
1,2-Dichloroethane	nd	<0.5	ug/l
Trichloroethene	nd	<0.5	ug/l
1,4-Dichlorobenzene	nd	<0.5	ug/l
1,1-Dichloroethene	nd	<0.5	ug/l
1,1,1 Trichloroethane	nd	<0.5	ug/l
Vinyl Chloride	nd	<0.5	ug/l
1,2-Dichlorobenzene	nd	<0.5	ug/l
cis-1,2-Dichloroethene	nd	<0.5	ug/l
trans-1,2-Dichloroethene	nd	<0.5	ug/l
1,2-Dichloropropane	nd	<0.5	ug/l
Ethylbenzene	nd	<0.5	ug/l
Chlorobenzene	nd	<0.5	ug/l
Styrene	nd	<0.5	ug/l
Tetrachloroethene	nd	<0.5	ug/l
Toluene	nd	<0.5	ug/l
m,p-Xylenes	nd	<0.5	ug/l
o-Xylene	nd	<0.5	ug/l
Dichloromethane	nd	<0.5	ug/l
1,1,2-Trichloroethane	nd	<0.5	ug/l
1,2,4-Trichlorobenzene	nd	<0.5	ug/l
Chloroform	nd	<0.5	ug/l
Bromodichloromethane	nd	<0.5	ug/l
Chlorodibromomethane	nd	<0.5	ug/l
Bromoform	nd	<0.5	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

Daily Analytical Laboratories
1621 W. Candletree Drive Peoria, Illinois 61614
Tel. (309) 692-5252 (800) 752-6651

Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-B FRACTION 02A Date & Time Collected not specified

VOLATILE ORGANICS ANALYSIS (cont.)
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
1,3-Dichlorobenzene	nd	<1.0	ug/l
Dibromomethane	nd	<1.0	ug/l
1,1-Dichloropropene	nd	<1.0	ug/l
1,1-Dichloroethane	nd	<1.0	ug/l
1,1,2,2-Tetrachloroethane	nd	<1.0	ug/l
1,3-Dichloropropane	nd	<1.0	ug/l
Chloromethane	nd	<1.0	ug/l
Bromomethane	nd	<1.0	ug/l
1,2,3-Trichloropropane	nd	<1.0	ug/l
1,1,1,2-Tetrachloroethane	nd	<1.0	ug/l
Chloroethane	nd	<1.0	ug/l
2,2-Dichloropropane	nd	<1.0	ug/l
2-Chlorotoluene	nd	<1.0	ug/l
4-Chlorotoluene	nd	<1.0	ug/l
Bromobenzene	nd	<1.0	ug/l
cis-1,3-Dichloropropene	nd	<1.0	ug/l
trans-1,3-Dichloropropene	nd	<1.0	ug/l
Ethylene Dibromide (EDB)	nd	<1.0	ug/l
1,2-Dibromo-3-Chloropropane	nd	<1.0	ug/l
1,2,4-Trimethylbenzene	nd	<1.0	ug/l
1,2,3-Trichlorobenzene	nd	<1.0	ug/l
n-Propylbenzene	nd	<1.0	ug/l
n-Butylbenzene	nd	<1.0	ug/l
Naphthalene	nd	<1.0	ug/l
Hexachlorobutadiene	nd	<1.0	ug/l
1,3,5-Trimethylbenzene	nd	<1.0	ug/l
4-Isopropyltoluene	nd	<1.0	ug/l
iso-Propylbenzene	nd	<1.0	ug/l
tert-Butylbenzene	nd	<1.0	ug/l
sec-Butylbenzene	nd	<1.0	ug/l
Trichlorofluoromethane	nd	<1.0	ug/l
Dichlorodifluoromethane	nd	<1.0	ug/l
Bromochloromethane	nd	<1.0	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

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Page 6 DAILY LABS REPORT Work Order # 94-07-650
Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-AB FRACTION 03A Date & Time Collected not specified
BLANK FOR SET 'A'

VOLATILE ORGANICS ANALYSIS
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
Benzene	nd	<0.5	ug/l
Carbon Tetrachloride	nd	<0.5	ug/l
1,2-Dichloroethane	nd	<0.5	ug/l
Trichloroethene	nd	<0.5	ug/l
1,4-Dichlorobenzene	nd	<0.5	ug/l
1,1-Dichloroethene	nd	<0.5	ug/l
1,1,1 Trichloroethane	nd	<0.5	ug/l
Vinyl Chloride	nd	<0.5	ug/l
1,2-Dichlorobenzene	nd	<0.5	ug/l
cis-1,2-Dichloroethene	nd	<0.5	ug/l
trans-1,2-Dichloroethene	nd	<0.5	ug/l
1,2-Dichloropropane	nd	<0.5	ug/l
Ethylbenzene	nd	<0.5	ug/l
Chlorobenzene	nd	<0.5	ug/l
Styrene	nd	<0.5	ug/l
Tetrachloroethene	nd	<0.5	ug/l
Toluene	nd	<0.5	ug/l
m,p-Xylenes	nd	<0.5	ug/l
o-Xylene	nd	<0.5	ug/l
Dichloromethane	nd	<0.5	ug/l
1,1,2-Trichloroethane	nd	<0.5	ug/l
1,2,4-Trichlorobenzene	nd	<0.5	ug/l
Chloroform	nd	<0.5	ug/l
Bromodichloromethane	nd	<0.5	ug/l
Chlorodibromomethane	nd	<0.5	ug/l
Bromoform	nd	<0.5	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

Daily Analytical Laboratories
1621 W. Candletree Drive Peoria, Illinois 61614
Tel. (309) 692-5252 (800) 752-6651

Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-AB FRACTION 03A Date & Time Collected not specified

VOLATILE ORGANICS ANALYSIS (cont.)
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
1,3-Dichlorobenzene	nd	<1.0	ug/l
Dibromomethane	nd	<1.0	ug/l
1,1-Dichloropropene	nd	<1.0	ug/l
1,1-Dichloroethane	nd	<1.0	ug/l
1,1,2,2-Tetrachloroethane	nd	<1.0	ug/l
1,3-Dichloropropane	nd	<1.0	ug/l
Chloromethane	nd	<1.0	ug/l
Bromomethane	nd	<1.0	ug/l
1,2,3-Trichloropropane	nd	<1.0	ug/l
1,1,1,2-Tetrachloroethane	nd	<1.0	ug/l
Chloroethane	nd	<1.0	ug/l
2,2-Dichloropropane	nd	<1.0	ug/l
2-Chlorotoluene	nd	<1.0	ug/l
4-Chlorotoluene	nd	<1.0	ug/l
Bromobenzene	nd	<1.0	ug/l
cis-1,3-Dichloropropene	nd	<1.0	ug/l
trans-1,3-Dichloropropene	nd	<1.0	ug/l
Ethylene Dibromide (EDB)	nd	<1.0	ug/l
1,2-Dibromo-3-Chloropropane	nd	<1.0	ug/l
1,2,4-Trimethylbenzene	nd	<1.0	ug/l
1,2,3-Trichlorobenzene	nd	<1.0	ug/l
n-Propylbenzene	nd	<1.0	ug/l
n-Butylbenzene	nd	<1.0	ug/l
Naphthalene	nd	<1.0	ug/l
Hexachlorobutadiene	nd	<1.0	ug/l
1,3,5-Trimethylbenzene	nd	<1.0	ug/l
4-Isopropyltoluene	nd	<1.0	ug/l
iso-Propylbenzene	nd	<1.0	ug/l
tert-Butylbenzene	nd	<1.0	ug/l
sec-Butylbenzene	nd	<1.0	ug/l
Trichlorofluoromethane	nd	<1.0	ug/l
Dichlorodifluoromethane	nd	<1.0	ug/l
Bromochloromethane	nd	<1.0	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

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Page 8 DAILY LABS REPORT Work Order # 94-07-650
Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-BB FRACTION 04A Date & Time Collected not specified
BLANK FOR SET 'B'

VOLATILE ORGANICS ANALYSIS
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
Benzene	nd	<0.5	ug/l
Carbon Tetrachloride	nd	<0.5	ug/l
1,2-Dichloroethane	nd	<0.5	ug/l
Trichloroethene	nd	<0.5	ug/l
1,4-Dichlorobenzene	nd	<0.5	ug/l
1,1-Dichloroethene	nd	<0.5	ug/l
1,1,1 Trichloroethane	nd	<0.5	ug/l
Vinyl Chloride	nd	<0.5	ug/l
1,2-Dichlorobenzene	nd	<0.5	ug/l
cis-1,2-Dichloroethene	nd	<0.5	ug/l
trans-1,2-Dichloroethene	nd	<0.5	ug/l
1,2-Dichloropropane	nd	<0.5	ug/l
Ethylbenzene	nd	<0.5	ug/l
Chlorobenzene	nd	<0.5	ug/l
Styrene	nd	<0.5	ug/l
Tetrachloroethene	nd	<0.5	ug/l
Toluene	nd	<0.5	ug/l
m,p-Xylenes	nd	<0.5	ug/l
o-Xylene	nd	<0.5	ug/l
Dichloromethane	nd	<0.5	ug/l
1,1,2-Trichloroethane	nd	<0.5	ug/l
1,2,4-Trichlorobenzene	nd	<0.5	ug/l
Chloroform	nd	<0.5	ug/l
Bromodichloromethane	nd	<0.5	ug/l
Chlorodibromomethane	nd	<0.5	ug/l
Bromoform	nd	<0.5	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

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Page 9 DAILY LABS REPORT Work Order # 94-07-650
Received: 07/15/94 Results by Sample

SAMPLE ID 1351-101-BB FRACTION 04A Date & Time Collected not specified

VOLATILE ORGANICS ANALYSIS (cont.)
USEPA METHOD 524.2

COMPOUNDS	CONC.	DETECTION LIMIT	UNITS
1,3-Dichlorobenzene	nd	<1.0	ug/l
Dibromomethane	nd	<1.0	ug/l
1,1-Dichloropropene	nd	<1.0	ug/l
1,1-Dichloroethane	nd	<1.0	ug/l
1,1,2,2-Tetrachloroethane	nd	<1.0	ug/l
1,3-Dichloropropane	nd	<1.0	ug/l
Chloromethane	nd	<1.0	ug/l
Bromomethane	nd	<1.0	ug/l
1,2,3-Trichloropropane	nd	<1.0	ug/l
1,1,1,2-Tetrachloroethane	nd	<1.0	ug/l
Chloroethane	nd	<1.0	ug/l
2,2-Dichloropropane	nd	<1.0	ug/l
2-Chlorotoluene	nd	<1.0	ug/l
4-Chlorotoluene	nd	<1.0	ug/l
Bromobenzene	nd	<1.0	ug/l
cis-1,3-Dichloropropene	nd	<1.0	ug/l
trans-1,3-Dichloropropene	nd	<1.0	ug/l
Ethylene Dibromide (EDB)	nd	<1.0	ug/l
1,2-Dibromo-3-Chloropropane	nd	<1.0	ug/l
1,2,4-Trimethylbenzene	nd	<1.0	ug/l
1,2,3-Trichlorobenzene	nd	<1.0	ug/l
n-Propylbenzene	nd	<1.0	ug/l
n-Butylbenzene	nd	<1.0	ug/l
Naphthalene	nd	<1.0	ug/l
Hexachlorobutadiene	nd	<1.0	ug/l
1,3,5-Trimethylbenzene	nd	<1.0	ug/l
4-Isopropyltoluene	nd	<1.0	ug/l
iso-Propylbenzene	nd	<1.0	ug/l
tert-Butylbenzene	nd	<1.0	ug/l
sec-Butylbenzene	nd	<1.0	ug/l
Trichlorofluoromethane	nd	<1.0	ug/l
Dichlorodifluoromethane	nd	<1.0	ug/l
Bromochloromethane	nd	<1.0	ug/l

nd = not detected
B = compound present in method blank
J = compound present but below method detection limit

TL-RTP Project: **28626** — 1613A TCDD Analysis (DB-5)
Client Sample: **1351-101-AB8 ORG** — Analysis File: **X943853**

Client Project:	DRINKING WATER				
Sample Matrix:	AQUEOUS	Date Received:	07/14/94	Spike File:	SP161F2S
TLRTP ID:	84-18-3	Date Extracted:	07/21/94	ICAL:	XF58133
		Date Analyzed:	07/27/94	CONCAL:	X943849
Sample Size:	0.920 L	Dilution Factor:	n/a	% Moisture:	100.0
Dry Weight:	n/a	Blank File:	X943850	% Lipid:	n/a
GC Column:	DB-5	Analyst:	JF	% Solids:	0.0

Analytes	Conc. (pg/L)	DL	Ratio	RT	Flags
2,3,7,8-TCDD	ND	1.8			—

Internal Standard	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDD	1020	46.8	0.83	33:44	—

Surrogate Standard (Type C)	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	122	55.9		33:44	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.83	33:30	—

Data Reviewer: DH 07/27/94

161F_PSR v:1.09. LARS 5.13.03

Triangle Laboratories of RTP, Inc.
801 Capitola Drive • Durham, North Carolina 27713
Phone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 23:25 07/27/94

CONSTRUCTION TECHNOLOGY LABS, INC

TL-RTP Project: **28626** — 1613A TCDD Analysis (DB-5)

Client Sample: **1351-101-BB8 ORGANIC** — Analysis File: **X943854**

Client Project:	DRINKING WATER				
Sample Matrix:	AQUEOUS	Date Received:	07/14/94	Spike File:	SP161F2S
TLRTP ID:	84-18-4	Date Extracted:	07/21/94	ICAL:	XF58133
		Date Analyzed:	07/27/94	CONCAL:	X943849
Sample Size:	0.910 L	Dilution Factor:	n/a	% Moisture:	100.0
Dry Weight:	n/a	Blank File:	X943850	% Lipid:	n/a
GC Column:	DB-5	Analyst:	JF	% Solids:	0.0

Analytes	Conc. (pg/L)	DL	Ratio	RT	Flags
2,3,7,8-TCDD	ND	1.1			—

Internal Standard	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDD	1530	69.4	0.79	33:44	—

Surrogate Standard (Type C)	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	168	76.5		33:45	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.79	33:31	—

Data Reviewer: _____ 07/27/94

161F_PSR v:1.09, LARS 5.13.03

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Printed: 23:25 07/27/94

TL-RTP Project: **28626** — 1613A TCDD Analysis (DB-5)
Client Sample: **1351-101-B8 ORGANIC** — Analysis File: **X943852**

Client Project:	DRINKING WATER				
Sample Matrix:	AQUEOUS	Date Received:	07/14/94	Spike File:	SP161F2S
TLRTP ID:	84-18-2	Date Extracted:	07/21/94	ICAL:	XF58133
		Date Analyzed:	07/27/94	CONCAL:	X943849
Sample Size:	0.920 L	Dilution Factor:	n/a	% Moisture:	100.0
Dry Weight:	n/a	Blank File:	X943850	% Lipid:	n/a
GC Column:	DB-5	Analyst:	VCA	% Solids:	0.0

Analytes	Conc. (pg/L)	DL	Ratio	RT	Flags
2,3,7,8-TCDD	ND	1.6			—

Internal Standard	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDD	1240	57.0	0.78	33:43	—

Surrogate Standard (Type C)	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	144	66.2		33:44	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.77	33:30	—

Data Reviewer: DON for DH 07/28/94

161F_PSR v:1.09. LARS 5.13.04

Triangle Laboratories of RTP, Inc.
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Phone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 09:16 07/28/94

TL-RTP Project: **28626** — 1613A TCDD Analysis (DB-5)
Client Sample: **1351-101-A8 ORG** — Analysis File: **X943851**

Client Project:	DRINKING WATER				
Sample Matrix:	AQUEOUS	Date Received:	07/14/94	Spike File:	SP161F2S
TLRTP ID:	84-18-1	Date Extracted:	07/21/94	ICAL:	XF58133
		Date Analyzed:	07/27/94	CONCAL:	X943849
Sample Size:	0.905 L	Dilution Factor:	n/a	% Moisture:	100.0
Dry Weight:	n/a	Blank File:	X943850	% Lipid:	n/a
GC Column:	DB-5	Analyst:	VCA	% Solids:	0.0

Analytes	Conc. (pg/L)	DL	Ratio	RT	Flags
2,3,7,8-TCDD	ND	1.5			—

Internal Standard	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDD	857	38.8	0.78	33:43	—

Surrogate Standard (Type C)	Conc. (pg/L)	% Recovery	Ratio	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	95.5	43.2		33:44	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.78	33:31	—

Data Reviewer: DH 07/27/94

161F_PSR v:1.09, LARS 5.13.03

Triangle Laboratories of RTP, Inc.
801 Capitola Drive • Durham, North Carolina 27713
Phone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 23:25 07/27/94

TELEDYNE BROWN ENGINEERING
Environmental Services
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
Phone (708) 564-0700 • Fax (708) 564-4517

Mr. Howard Kanare
Construction Technology Laboratories, Inc.
5420 Old Orchard Road
Skokie, IL 60077-1030

LABORATORY REPORT NO.: 8100-3145
DATE: 07-25-94
SAMPLES RECEIVED: 07-13-94
TYPE OF REPORT: COMPLETE
PURCHASE ORDER NO.: 14102 B

Sample Description	Lab Code	Concentration (pCi/L) gross alpha	gross beta
1351-101-A5	SPW-2939	<0.4	11.9±0.9
1351-101-A10	SPW-2940	<0.9	13.1±0.9
1351-101-AB5	SPW-2941	<0.5	<0.5
1351-101-AB10	SPW-2942	<0.8	<0.6
1351-101-B5	SPW-2943	2.0±0.9	95.1±1.9
1351-101-B10	SPW-2944	5.7±2.4	81.5±1.9
1351-101-BB5	SPW-2945	<0.6	<0.6
1351-101-BB10	SPW-2946	<1.1	<0.6

The error given is the probable counting error at 95% confidence level. Less than (<) values are based on 3 sigma counting error for the background sample.

Sincerely,

Tony Coorlim,
Special Projects

TC:lsd

APPROVED BY L. G. Huebner /bb
L. G. Huebner, M. S.
Manager

SAMPLES RETAINED THIRTY DAYS AFTER ANALYSIS

TELEDYNE BROWN ENGINEERING
Environmental Services
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
Phone (708) 564-0700 • Fax (708) 564-4517

Mr. Howard Kanare
Construction Technology Laboratories, Inc.
5420 Old Orchard Road
Skokie, IL 60077-1030

LABORATORY REPORT NO: 8100-3183
DATE: 09-07-94
SAMPLES RECEIVED: 08-22-94
TYPE OF REPORT: COMPLETE
PURCHASE ORDER NO.: 14300B

Dear Mr. Kanare:

Below are the results of the analyses for gamma emitting isotopes in two (2) water samples.

Sample Description	1351-121-B5	1351-121-BB10
Lab Code	SPW-4096	SPW-4097
Isotope	Concentration (pCi/L)	
K-40	346.4±52.2	<37.0
Mn-54	<1.5	<1.9
Co-58	<1.9	<2.1
Co-60	<1.4	<2.3
Fe-59	<4.0	<4.3
Zn-65	<2.0	<1.8
Ru-103	<1.1	<2.4
Ru-106	<13.6	<13.8
Cs-134	<2.2	<1.4
Cs-137	<1.7	<2.4

The error given is the probable counting error at 95% confidence level. Less than values are bases on 3.0 sigma counting error for the background sample.

Sincerely,

Tony Coorlim,
Special Projects

TC:lsd

APPROVED BY

L. G. Huebner, M. S.
Manager

SAMPLES RETAINED THIRTY DAYS AFTER ANALYSIS